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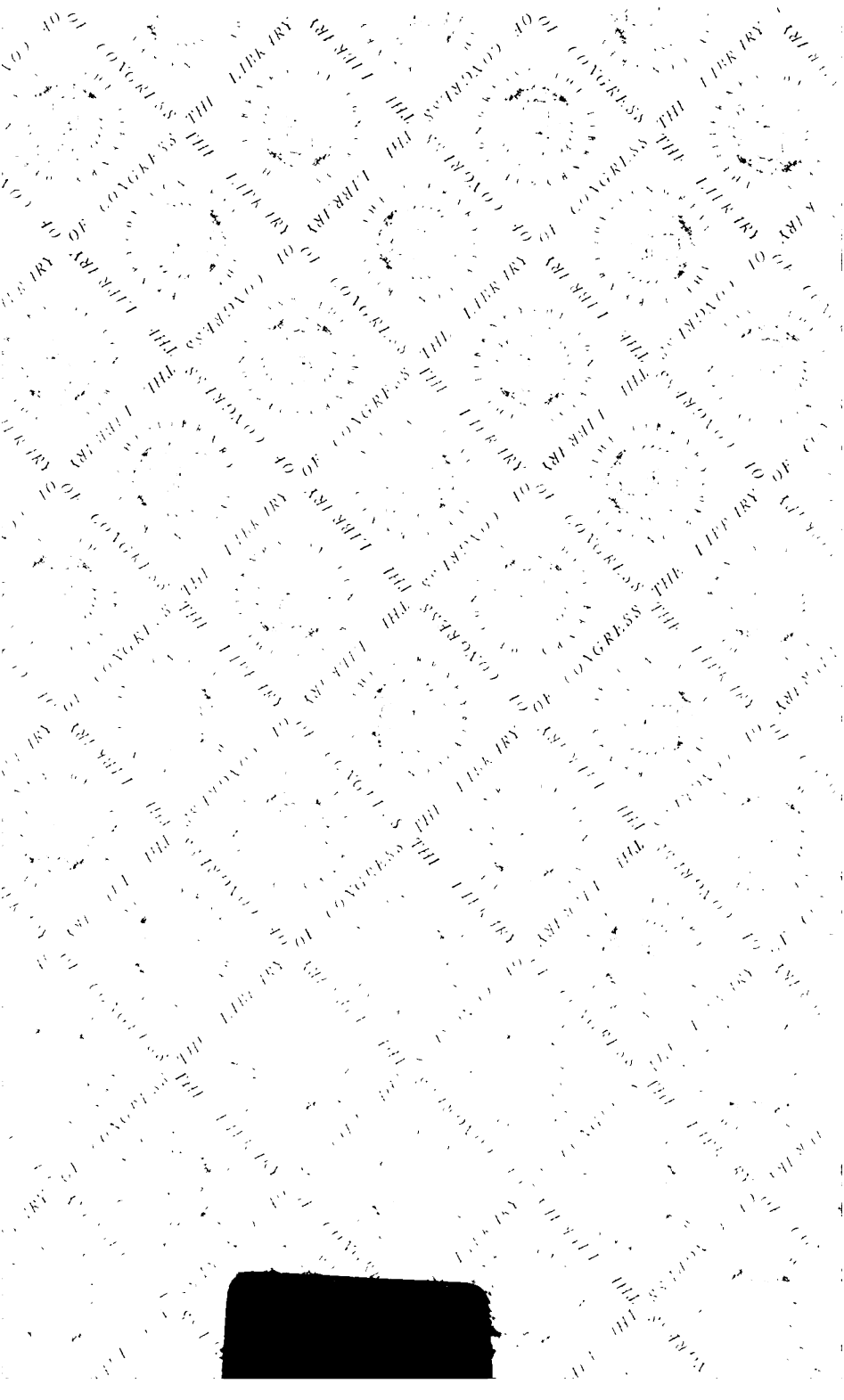
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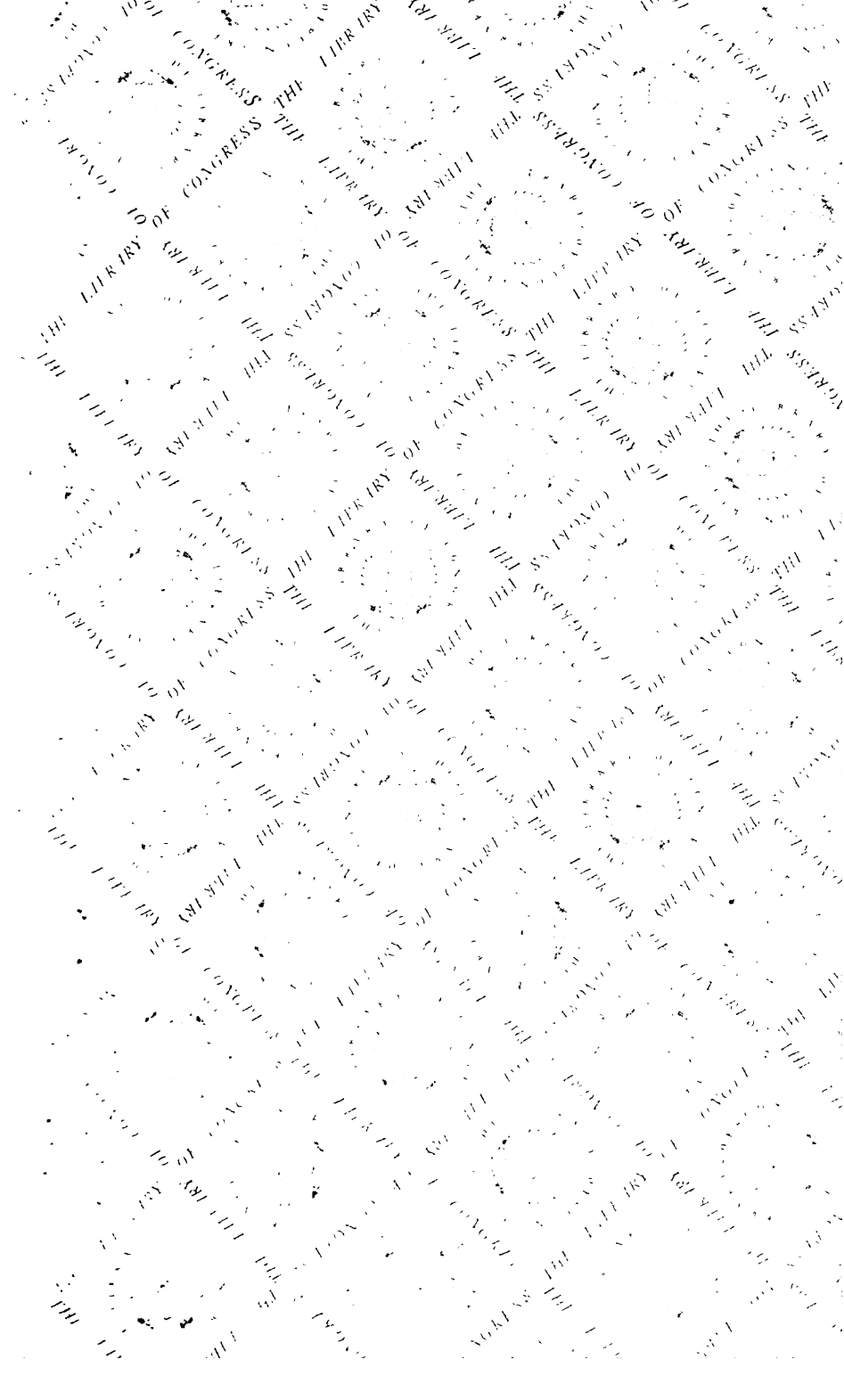
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THE
JOURNAL

OF THE
ROYAL AGRICULTURAL SOCIETY
OF ENGLAND.

VOLUME THE FOURTH.
1843.

PRACTICE WITH SCIENCE.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.

MDCCCXLIII.

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THESE EXPERIMENTS, IT IS TRUE, ARE NOT EASY; STILL THEY ARE IN THE POWER OF EVERY THINKING HUSBANDMAN. HE WHO ACCOMPLISHES BUT ONE, OF HOWEVER LIMITED APPLICATION, AND TAKES CARE TO REPORT IT FAITHFULLY, ADVANCES THE SCIENCE, AND, CONSEQUENTLY, THE PRACTICE OF AGRICULTURE, AND ACQUIRES THEREBY A RIGHT TO THE GRATITUDE OF HIS FELLOWS, AND OF THOSE WHO COME AFTER. TO MAKE MANY SUCH IS BEYOND THE POWER OF MOST INDIVIDUALS, AND CANNOT BE EXPECTED. THE FIRST CARE OF ALL SOCIETIES FORMED FOR THE IMPROVEMENT OF OUR SCIENCE SHOULD BE TO PREPARE THE FORMS OF SUCH EXPERIMENTS, AND TO DISTRIBUTE THE EXECUTION OF THEM AMONG THEIR MEMBERS.

VON THAER, *Principles of Agriculture.*

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ERRATUM.

Page 303, line 6, *for* "yellowish," *read* "fawn-coloured."

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1842—1843.

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VAN DE WEYER, M. SYLVIAN, Belgian Minister.

Royal Agricultural Society of England.

GENERAL MEETING,

12, HANOVER SQUARE, SATURDAY, DECEMBER 10, 1842.

REPORT OF THE COUNCIL.

THE Society having now attained an amount of nearly 6500 members, and excited throughout the kingdom, and even in distant colonies of the empire, a lively interest in the prosecution and success of agricultural improvement, it has become a suitable subject of inquiry at the present moment, to ascertain in what manner, and to what extent, its labours have tended effectively to disseminate a knowledge of improved systems and carefully-tested practices of modern husbandry, and to advance in their turn, by experiment, observation, and sound deduction, the standard of correctness in our general principles of agricultural reasoning.

This important task has been undertaken and accomplished by Mr. Pusey : and in the portion of the Journal distributed within these few weeks among the members, your former President has given to the agricultural world a distinct and most interesting survey of the successful mode in which the objects of the Society have slowly, but steadily and effectively, developed themselves during that brief period of its history. That contribution to your Journal will be regarded as a most important document by the numerous members into whose hands it has, in the ordinary course of circulation, already found its way ; and while it supplies to the

Council a ready exposition of the steady progress of the Society in its career of usefulness, it affords to the members at large a satisfactory assurance of the important results which must ultimately be obtained in the prosecution of its national objects.

The Council have to record with great satisfaction the successful issue of the annual country meeting of the Society at Bristol. The distinguished reception given to the deputation by Mr. Phippen, at the termination of his mayoralty, and his subsequent co-operation, as a member of the local committee, during the preparations for the meeting, at once established that perfect cordiality between the citizens of Bristol and the members of the Society, which the no less liberal, zealous, and hospitable co-operation of his successor, Mr. Franklyn, contributed to maintain. To Mr. Franklyn, as chief magistrate of the city of Bristol, the Society were indebted for every attention, and especially for the excellent arrangements made under his authority and that of the high-sheriff, magistrates, and corporation, in maintaining the public order of the place, and in consulting the convenience and safety of the members who attended the meeting. The best thanks of the Society have already been given to both these gentlemen.

Mr. Handley, as your President, conveyed also at the time the thanks of the Society to Mr. M'Adam, the Chairman, and to the members of the Victoria Committee, for the gratuitous use of the spacious and commodious rooms in which the official business of the meeting was transacted, and the council-dinner took place ; to Mr. Adams, the owner of the site of the show-yard ; to the Bristol Institution, for the use of their theatre, in which Mr. Smith, of Deanston, delivered his valuable lecture on draining to the members of the Society ; and to the Commercial-rooms' Committee, the Steam-ship Company, the directors of the Clifton Suspension-bridge, the vestry of St. Mary Redcliff, and the other public bodies who gratuitously threw open to the free access and inspection of the members whatever they respectively possessed of general interest. The Council felt equally under obligation, at the same time, to the Society of Merchant Venturers, Mr.

Ireland Clayfield, Mrs. Worsley, and other individuals, who had liberally offered to the Society the free occupation and disposal of their land. To Mr. Miles, as the Chairman, and to the Local Committee the Society were indebted for the excellent local arrangements of the period. The registration of lodgings by Mr. Webb Hall contributed essentially to the convenience of the members who attended the meeting; and the devotion of time and energies so cheerfully given by Mr. Marmont, the Secretary of the Local Committee, to the cause of the Society, and the numerous surveys and plans of proposed and adopted sites for the purpose of the meeting, including a detailed plan of the Victoria Grounds, drawn to a large scale, constituted an amount of invaluable service, which the Council most thankfully acknowledge.

In addition to the splendid exhibition of Devon cattle and other stock at the Meeting, and an exhibition of the greatest variety of new agricultural implements hitherto made on any similar occasion, of which an elaborate report has been drawn up by the judges, and printed in the Journal, the numerous assemblage of persons interested in agriculture from every part of the kingdom contributed to render the Meeting of a highly interesting character. The presence of his Royal Highness the Duke of Cambridge, as a governor, and of the Hon. Henry Everett, as an honorary member, and their lively participation in the proceedings of the Meeting, were circumstances which, in many national points of view, added a peculiar interest to the occasion.

The Council have received from the deputation to the town of Derby a favourable report of the various sites inspected as suitable for the purposes of the show-yard, pavilion, official rooms, and lecture; to which they were conducted by the mayor, Mr. Colville the chairman, and the members of the local committee; and they have announced in the prize sheet, which has been extensively advertised in the public papers of that neighbourhood, as well as in the London agricultural papers, that the principal day of the show is fixed for Thursday, the 13th of July; and that all certificates will be required to be lodged with the secretary by the 1st of June preceding. The Council beg to call the attention of the

members of the Society to this rule ; they having decided that in no case whatever shall any certificate be received after that date.

The Finance Committee have reported that, notwithstanding the hopes entertained by the Council of the payment of the arrears of subscription, there still remains a large amount of outstanding debt due to the Society under this head ; which it will be their duty very early to take into their most mature and serious consideration.

The Council have, since their last report, passed a resolution affecting the order of their meetings, and defining the character of the business to be transacted at them ; limiting to the first Wednesday in every month, at which any governors can be present, the deliberations and resolutions on the strict official details of the Society's business ; and throwing open to the meetings held on the three other Wednesdays of the month the presentation and discussion of communications on the subject of agricultural interest—all members of the Society being allowed the privilege of attending these last mentioned weekly meetings of the Council.

At the close of the session in August last, the Council confided to Mr. Dean, as honorary director of the works, the arrangements required for adapting the various parts of the Society's house to the several objects and purposes decided upon by them at their former meetings. To this important task, Mr. Dean, forming a quorum of the house committee, with the friendly co-operation of Mr. Burke and Mr. Gibbs, devoted himself during the late autumnal vacation, with a success, and amount of time and exertion, which fully entitle him to the best acknowledgments of the Society ; and has presented to the Council his detailed reports of the progress of the works, and explained at length the various objects to which each department of his plan is adapted.

Mr. Dean has arranged the basement of the house as a depository for the display of such implements and other objects as the Council may think fit to exhibit. On the first floor, in addition to the council and committee rooms, a library and reading-room, open to members, has been provided, in which it is intended to form a standard collection of the best works on agricultural

science and practice ; and to take in, as they appear, the various English and foreign periodicals of an agricultural character ; and where cases have already been fitted up for the exhibition of collections of wheat, grasses, wool, and other objects of permanent interest. The remainder of the house comprises the secretary's apartments, the porter's hall and dwelling-room, the secretary's and clerks' rooms, and the various offices connected with the establishment ; all of which have been fitted up with the greatest attention to the comfort and convenience of the several parties to whom they apply, and, at the same time, with a due regard to judicious economy in the outlay.

The Council have resolved not to give the prize to any of the samples of seed-wheat selected at the Liverpool Meeting, and tried during the past season with other varieties commonly grown in the respective neighbourhoods where the trials have been made, and of which the results are given in the last part of the Journal.

The Council have to report to the General Meeting the following adjudication of the prizes for the essays and reports of experiments in the present year :—

To Barugh Almack, late of Bishop Burton, in the East Riding of the county of York, and now of No. 11, Great George Street, Westminster, and 23, Alexander Square, Brompton—the prize of 20 sovereigns, for the best report of experiments on the drill husbandry of turnips.

To Andrew Leighton, of Chelveston, near Higham Ferrers, Northamptonshire—the prize of 20 sovereigns, for the best account of the natural history, anatomy, habits, and economy of the wire-worm, and the best means of protection against its ravages.

To the Rev. William Lewis Rham, M.A., vicar of Winkfield, near Bracknell, Berkshire—the prize of 20 sovereigns, for the best essay on the mechanical properties of the plough.

To John Barton, of East Leigh, near Emsworth, Hampshire—the prize of 20 sovereigns, for the best account of the rotations of crops suited for light lands.

To George Fownes, doctor of philosophy in the University of Giessen, and chemical lecturer in the Medical School of the

Charing Cross Hospital—the prize of 20 sovereigns, for the best essay on the food of plants.

The Council have further to report, that no essays were sent in to compete for the prize of 15 sovereigns offered by the Society for the best account of the varieties of wheat suited to different soils, nor any essay of sufficient merit on the making of cheese. They have received from the judges appointed to consider the merits of the essays competing for the gold medal offered by the Society for the best account or record of the prognostics or natural signs of changes in the weather, their report on the relative merits of the essays on this subject; and, in accordance with the conditions of that prize, the Council have placed copies of the selected essays in the hands of Mr. Morton, jun., of the Whitfield Example Farm, for the purpose of a twelvemonth's accurate and extensive trial of the practical value and general correctness of the rules laid down by the respective writers of these essays, as indicating the signs of such changes of weather.

The Council, in pursuance of the conditions of the prize of 10 sovereigns for an account of the best mode of curing butter for future consumption, and for preservation in foreign countries, have had the various samples sent in by the competitors submitted to the examination and judgment of two eminent dairymen of the metropolis, who have decided, after a very careful examination, that the whole of the samples of butter competing for the Society's prize are of a very inferior quality, and utterly worthless as proofs of any efficient modes having been employed of curing the butter for future consumption.

The essays for the prize of 20 sovereigns, for the best account of the rotations of crops suited for heavy lands, have received the most careful examination and scrutiny of the judges in that department, without, however, their agreeing in their decision on the particular essay most worthy of the prize. The Council have accordingly appointed another member of the Society to act as umpire on the comparative merits of the two contending essays, each of which has on this occasion been selected by the judges respectively as the best.

The Council have placed the names of the Hon. Henry

Everett, the American minister; of Dr. Playfair, the translator of Dr. Liebig's Organic Chemistry applied to Agriculture; and of Mr. Edward Solly, jun., lecturer on agricultural chemistry to the Horticultural Society of London, on the list of the honorary members of the Society; and they acknowledge, with their best thanks, the valuable service Dr. Playfair has rendered to the Society in delivering before the members, at their present December meeting, two lectures on the important subject of the application of the principles of physiology to the fattening of cattle.

By order of the Council,

JAMES HUDSON, SECRETARY.

General Meetings of 1843.

The ANNIVERSARY MEETING, in London, on Monday, May 22, 1843, at twelve o'clock precisely.

The ANNUAL COUNTRY MEETING, at Derby: principal day of the Show, Thursday, July 13, 1843.

The GENERAL DECEMBER MEETING, in London, on Saturday December 9, at twelve o'clock precisely.

COTTAGE ECONOMY.—Mr. Main's article on Cottage Gardening, and Mr. Burke's compilation on Cottage Economy and Cookery, have each been reprinted from the Journal in a separate form, for cheap distribution. Either or both of these tracts may be obtained by members at the rate of 1s. per dozen copies, on their enclosing to the Secretary a post-office money-order for the number required; at the same time stating the most eligible mode of conveyance by which the copies can be transmitted to their address.

VOLUMES OF THE JOURNAL.—The first Volume of the Journal consists of *four* parts, the second and third Volumes of *three* parts each (the second and third parts of the third Volume being comprised in a double number). The Journal will in future be published half-yearly, namely, the first half-volume in the spring and the second in the autumn of each year.

SUBSCRIPTIONS may be paid to the Secretary, in the most direct and satisfactory manner, by means of Post-office orders, to be obtained on application at any of the principal Post-offices throughout the kingdom. Subscriptions are due in advance, for each year, on the 1st of January; and are in arrear if unpaid by the 1st of June ensuing. No Member is entitled to the Journal whose subscription is in arrear.

Meeting at Derby.

PRINCIPAL DAY OF THE SHOW: THURSDAY, JULY 13, 1843.

THE PRIZES ARE OPEN TO GENERAL COMPETITION.

FORMS OF CERTIFICATES TO BE PROCURED ON APPLICATION TO THE SECRETARY, 12,
HANOVER SQUARE, LONDON.

ALL CERTIFICATES MUST BE RETURNED, FILLED UP, TO THE SECRETARY, ON OR
BEFORE THE 1ST OF JUNE, 1843; THE COUNCIL HAVING RESOLVED,
THAT IN NO CASE WHATEVER SHALL ANY CERTIFICATE
BE RECEIVED AFTER THAT DATE.

Prizes for Improving the Breed of Cattle.—1843.

SHORT-HORNS.

CLASS

1. To the owner of the best Bull calved previously
to the 1st of January, 1841 Thirty Sovereigns.
To the owner of the second-best ditto ditto Fifteen Sovereigns.
2. To the owner of the best Bull calved since the
1st of January, 1841, and more than one
year old Twenty Sovereigns.
3. To the owner of the best Cow in milk Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not ex-
ceeding three years old Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer Ten Sovereigns.

HEREFORDS.

1. To the owner of the best Bull calved previously
to the 1st of January, 1841 Thirty Sovereigns.
To the owner of the second-best ditto ditto Fifteen Sovereigns.
2. To the owner of the best Bull calved since the
1st of January, 1841, and more than one
year old Twenty Sovereigns.
3. To the owner of the best Cow in milk Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not ex-
ceeding three years old Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer Ten Sovereigns.

DEVONS.

1. To the owner of the best Bull calved previously
to the 1st of January, 1841 Thirty Sovereigns.
To the owner of the second-best ditto ditto Fifteen Sovereigns.

CLASS

2. To the owner of the best Bull calved since the 1st of January, 1841, and more than one year old Twenty Sovereigns.
3. To the owner of the best Cow in milk . . . Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not exceeding three years old Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer . . . Ten Sovereigns.

CATTLE OF ANY BREED, OR CROSS:

Not qualified to compete as Short-horns, Herefords, or Devons.

1. To the owner of the best Bull calved previously to the 1st of January, 1841 Thirty Sovereigns.
To the owner of the second-best ditto ditto . . . Fifteen Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1841, and more than one year old Twenty Sovereigns.
3. To the owner of the best Cow in milk . . . Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not exceeding three years old Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer . . . Ten Sovereigns.

HORSES.

1. To the owner of the best Cart-Stallion of 4 years old and upwards Thirty Sovereigns.
To the owner of the second-best ditto ditto . . . Twenty Sovereigns.
2. To the owner of the best two years-old ditto foaled since the 1st of January, 1841 . . . Fifteen Sovereigns.
3. To the owner of the best Cart-Mare and Foal . . . Twenty Sovereigns.
To the owner of the second-best ditto . . . Ten Sovereigns.
4. To the owner of the best two years-old Filly . . . Ten Sovereigns.
5. To the owner of the best THOROUGH-BRED STALLION, which shall have served Mares at a price not exceeding three guineas (and with a groom's fee of not more than five shillings), in the season of 1843 Thirty Sovereigns.

S H E E P.

Prizes for Improving the Breed of Sheep.—1843.

LEICESTERS.

CLASS

1. To the owner of the best Shearling Ram . . . Thirty Sovereigns.
To the owner of the second-best ditto . . . Fifteen Sovereigns.
2. To the owner of the best Ram of any other age . . . Thirty Sovereigns.
To the owner of the second-best ditto . . . Fifteen Sovereigns.

CLASS

3. To the owner of the best pen of Five Shearling
 Ewes Ten Sovereigns.
 To the owner of the second-best ditto ditto . . . Five Sovereigns.

SOUTH DOWNS, OR OTHER SHORT-WOOLLED SHEEP.

1. To the owner of the best Shearling Ram . . . Thirty Sovereigns.
 To the owner of the second-best ditto . . . Fifteen Sovereigns.
2. To the owner of the best Ram of any other age . Thirty Sovereigns.
 To the owner of the second-best ditto . . . Fifteen Sovereigns.
3. To the owner of the best pen of Five Shearling
 Ewes Ten Sovereigns.
 To the owner of the second-best ditto ditto . . . Five Sovereigns.

LONG-WOOLLED SHEEP:

Not qualified to compete as Leicesters.

1. To the owner of the best Shearling Ram . . . Thirty Sovereigns.
 To the owner of the second-best ditto . . . Fifteen Sovereigns.
2. To the owner of the best Ram of any other age . Thirty Sovereigns.
 To the owner of the second-best ditto . . . Fifteen Sovereigns.
3. To the owner of the best pen of Five Shearling
 Ewes Ten Sovereigns.
 To the owner of the second-best ditto ditto . . . Five Sovereigns.

Pigs.

1. To the owner of the best Boar of a large breed . Ten Sovereigns.
 To the owner of the second-best ditto ditto . . . Five Sovereigns.
2. To the owner of the best Boar of a small breed . Ten Sovereigns.
 To the owner of the second-best ditto ditto . . . Five Sovereigns.
3. To the owner of the best breeding Sow of a large
 breed Ten Sovereigns.
4. To the owner of the best breeding Sow of a small
 breed Ten Sovereigns.
5. To the owner of the best pen of three breeding
 Sow-Pigs of the same litter, above four and
 under nine months old Ten Sovereigns.

AGRICULTURAL IMPLEMENTS.

- For the Plough best adapted to heavy land . . . Twenty Sovereigns.
 For the Plough best adapted to light land . . . Twenty Sovereigns.
 For the Drill which shall possess the best method of
 distributing compost, or other manures in a
 moist or dry state, quantity being especially
 considered Thirty Sovereigns.

N.B.—Other qualities being equal, the preference will be given to
 the Drill which may be best adapted to cover the manure with
 soil before the seed is deposited.

- For the best Scarifier Fifteen Sovereigns.
 For the best Chaff-Cutter Ten Sovereigns.
 For the Draining Tile for agricultural purposes,
 which shall have been *bond fide* sold at the
 cheapest rate during the past year, regard being
 had to the local circumstances affecting the cost
 of production, and which, in the opinion of the
 Judges, shall be sufficiently durable Ten Sovereigns.
 For the best set of Harrows Ten Sovereigns.
 For the best agricultural carriage, with or without
 springs, for the general purposes of road and
 field Twenty Sovereigns.
 For the best and cheapest Stack-covering, to super-
 sede Thatching Twenty Sovereigns.
 For the best Drill-Presser Ten Sovereigns.
 For the best Churn Five Sovereigns.

The Society wishes to call the attention of Machine-makers to Improved Steam Apparatus for Roots,—to small or portable Corn-Mills,—to Broad Shares for paring Stubbles,—to a Rake for collecting Couch,—to Agricultural Harness and Gearing generally: for which Prizes or Medals will be awarded by the Judges.

The Judges will especially consider the selling-price of the Implements exhibited, which must be stated in the certificate; and they are instructed to withhold Prizes where there shall not appear to be sufficient merit.

Printed Forms of Certificates of Entry by Exhibitors may be obtained of the Secretary, at No. 12, Hanover Square, London, and must be returned to him, filled up, by the 1st of June, 1843; the Council having decided, that in no case whatever shall any Certificate be received after that date. All Implements must be in the Show-Yard before Nine o'clock on the evening of Friday, the 7th of July; and all Implements so admitted will be liable to be proved by actual trial on the recommendation of the Judges.

The Judges will make a selection of such Ploughs and other Implements as appear to them to possess peculiar merit, and reserve their final decision, where necessary, until they shall have tested them in a subsequent trial, to be hereafter arranged, and to take place at a suitable season of the year.

CHEESE.

- To the Exhibitor of the best Hundred-weight of
 Cheese (of any kind) Ten Sovereigns.
 To the Exhibitor of the second-best ditto (of any
 kind) Five Sovereigns.
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EXTRA STOCK, ROOTS, AND SEEDS.

- For Extra Stock of any kind, not shown for any of
 the above Prizes, and for Roots, Seeds, &c.,
 Prizes may be awarded and apportioned, by the
 Committee and Judges, to an amount not ex-
 ceeding in the whole Fifty Sovereigns.

ANY NEW IMPLEMENT.

For the Invention of any new Agricultural Implement, such sum as the Society may think proper to award.

SEED-WHEAT.

I. Thirty Sovereigns, or a Piece of Plate of that value, will be given to the Exhibitor, at the Meeting at Derby, of the best 14 bushels of White Wheat, of the harvest of 1842, and grown by himself.

II. Thirty Sovereigns, or a Piece of Plate of that value, will be given to the Exhibitor, at the Meeting at Derby, of the best 14 bushels of Red Wheat, of the harvest of 1842, and grown by himself.

III. Twenty Sovereigns, or a Piece of Plate of that value, will be given to the Exhibitor, at the Meeting at Derby, of the best 14 bushels of Spring Wheat, of the harvest of 1842, and grown by himself.

Competitors are requested to send with their wheat, specimens, fairly taken, of the same in the ear, with the whole of the straw, in a bundle not less than one foot in diameter, and with the roots attached.

[12 bushels of the wheat will be sealed up by the judges, and one of the remaining bushels of each variety will be exhibited as a sample to the public; the other being kept for comparison with the produce of the next year. At the General Meeting in December, 1844, the prizes will be awarded.]

The two best samples of each of these three classes of wheat, without at that time distinguishing, in any of the cases, between the comparative merits of either sample, will be selected by the judges appointed for the Meeting at Derby; and will be sown, under the direction of the Society (the winter wheats in the autumn of 1843, and the spring wheat not earlier than the 1st of March, in 1844) by four farmers; who will make their report, upon which the prizes will be awarded, provided there be sufficient merit in any of the samples. Ten Sovereigns will be given at the Meeting at Derby to each Exhibitor whose Wheat has been selected for trial.

. No variety of Wheat which has been selected for trial at any previous show shall be qualified to compete.

GENERAL REGULATIONS FOR EXHIBITION.

I. No stock can be admitted for exhibition unless the necessary certificates, filled in, on the printed form prescribed, and signed by the exhibitor (or his agent), in the manner directed, have been delivered to the Secretary, or sent (postage free), so as to reach the Society's house, No. 12, Hanover Square, London, on or before the 1st of June next; after which day no certificates will be accepted. Proper admission-tickets, corresponding to the certificates, will be sent to the exhibitors, and be required to be delivered with their animals on presenting them for admission into the Show-yard; when the printed numbers will also be

required to be affixed to each animal, respectively, by the persons who are in charge of them.

II. The name and residence of the breeder of each animal exhibited, when known, should be stated.

III. Non-members will be required to pay five shillings for every head or lot of live stock, or articles of exhibition, before obtaining tickets of admission to bring their stock into the Show-yard; and this amount must be remitted by means of post-office order, made payable to the Secretary, and enclosed with the certificate.

IV. The same animal cannot be entered for two classes; and in all cases the age of an animal is to be computed from the day of birth, excepting in the case of horses, when the year only will be required.

V. No animal which won a first prize in any class at the previous meetings of the Society will be allowed to compete for a similar prize at the meeting at Derby.

VI. The sheep exhibited for any of the prizes must have been really and fairly shorn between the 1st of May and the 1st of July, 1843, both days inclusive.

VII. Persons intending to exhibit Extra Stock must give notice to the Secretary on or before the 1st of June next.

VIII. Any person who shall have been proved, to the satisfaction of the Council, to have been excluded from showing for prizes at the exhibition of any society in consequence of having been convicted of an attempt to obtain a prize by giving a false certificate, shall not be allowed to compete for any of the prizes offered by the Royal Agricultural Society of England.

IX. In case any gentleman, or number of gentlemen, wish to offer a prize for any class of stock not distinctly specified among the prizes offered by the Society, he or they will be allowed to offer such prize at the meeting at Derby; and the stock which shall compete for such prize shall be exhibited, subject to such conditions as shall be decided upon by the Council; and the prize awarded by such of the judges as the Council shall select. Animals exhibited for such prizes shall not be prevented from competing for any of the prizes offered by the Society for which they are qualified.

X. Stock of every description can only be admitted into the Show-yard on the presentation with them of the proper tickets, and between the hours of eight in the morning and eight at night, on Tuesday the 11th of July; and must remain in the Show-yard until after six o'clock in the afternoon of Thursday the 13th of July; and no animal can be removed from its place, or taken out of the Show-yard, without leave in writing from the Director or Stewards; nor will they be allowed to be removed from the yard until after ten o'clock on the morning of Friday the 14th of July, without leave in writing from the Director or Stewards of the yard.

N.B.—Stallions only may be removed for the night.

XI. Persons intending to exhibit Seed-wheat, Implements, Seeds, Roots, Cheese, &c., must give notice to the Secretary of the Society, in Hanover Square, London, on or before the 1st of June, and furnish him with a description (written on one side only of the certificate) of the

articles intended to be shown, and the probable space which may be required for them (bearing in mind that the sheds are only 20 feet wide), in order that the Stewards may be enabled properly to apportion the space allotted for the exhibition of such articles among the various parties making application; and the articles to be exhibited must be brought to the Show-yard before nine o'clock on the evening of Friday, July 7th, as none will be admitted after that day and hour.

XII. Whenever reference is made to weights and measures, it is to be considered that the imperial weights and measures only are referred to.

XIII. The Judges of Stock are to have the whole of Wednesday, the 12th of July, for making their adjudication, and signing their award; and the Director and Stewards are instructed to take care that no Governor or Member (including the Council), stranger or competitor, be admitted, under any pretence whatever, into the yard on that day.

XIV. No prize will be given when the Judges shall be of opinion that there is not sufficient merit in the stock, implements, &c., to justify an award, especially in cases where there is no competition.

XV. All persons admitted into the Show-yard shall be subject to the rules, orders, and regulations of the Council.

* * Further information respecting regulations of detail may be obtained from the Secretary, at No. 12, Hanover Square, London.

EXTRA STOCK.

Persons intending to exhibit animals as Extra Stock can alter the blank Certificates to answer their purpose.

A SALE BY AUCTION, of Stock and other articles exhibited at the Meeting, will take place in the Show-yard, on the morning of Friday, the 14th of July, at ten o'clock precisely, the Society paying the Auctioneer for his attendance on the occasion. Any Person intending to offer for sale Stock or other articles exhibited must give notice on his Certificate to be sent in by the 1st of June, AS NO ENTRIES WILL BE ALLOWED AFTER THAT DAY, and no person will be allowed to withdraw such entries of Sale by auction, unless on paying a forfeit of Five Shillings for each head or lot of Stock or articles exhibited. The Regulations and Conditions of the sale will be published for the information of Exhibitors previously to the 1st of June.

INSTRUCTIONS TO THE JUDGES.

As the object of the Society in giving the prizes for neat cattle, sheep, and pigs, is to promote improvement in breeding stock, the Judges, in making their award, are instructed not to take into their consideration the present value to the butcher of animals exhibited, but to decide according to their relative merits for the purpose of breeding.

In the Class for horses, the Judges, in awarding the prizes, are instructed, in addition to symmetry, to take activity and strength into their consideration.

ESSAYS AND REPORTS ON VARIOUS SUBJECTS.

Prizes for 1844.

PRIZE ESSAYS.

I. WATER-MEADOWS AND UPLAND PASTURES.

TWENTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Account of the Comparative Value of Water-meadows and Uplands generally for Cattle, Sheep, and Horses, but especially for Milch Cows.

Competitors will be required to state the following particulars in reference to the trials instituted for the purpose of obtaining practical results on this subject :—

1. The nature of the soil and its state of drainage to be described ; and equal portions of upland and water meadow to be selected.
2. Equal numbers of cows of the same age and breed (not less than four in number) to be separately fed in pairs, on each different kind of grass, and to be changed once from one kind of grass to the other ; and the quantity, as well as the quality, of the milk from such cows to be ascertained by the lactometer.
3. If made into hay, the quantity of each sort produced on the land, and the quantity, as well as quality, of the milk which has been produced, to be ascertained in a similar manner.
4. The value of spring food and grass, whether in rowen or pasture.
5. The same conditions to be applicable to the feeding of sheep-stock ; stating the numbers which the same quantity of each land has separately maintained during a certain period ; and whether or not subject to the rot by the flooding.
6. In regard to irrigating the land : the primary cost, whether of catch-water or flow-meadow, of its formation, and the annual expense of management, including the repair of sluices ; together with the former and present rent or value.

Competitors are also requested to state, as far as their observation may have extended, the comparative value of the grasses of water-meadows and uplands, when cut into hay, and consumed as fodder.

II. INFLUENCE OF CLIMATE.

TWENTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Essay on the Influence of Climate upon Cultivation within the limits of Great Britain and Ireland.

There being good reason to suppose that the discordant practices of farming in different districts may be partly attributed to the influence of climate, competitors for this prize must endeavour to describe those practices, and to trace them to the variation of climate.

Under the term climate must be included the degree of cold or heat, moisture or drought, arising whether from latitude, elevation, neighbourhood to or distance from the sea, &c.

Variation in practice may be looked for in the management of artificial and natural grass, the growth of root-crops, the depth of ploughing, the time of sowing, the choice of white crops, &c.

III. INDICATIONS OF FERTILITY OR BARRENNESS.

FIFTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Essay on the Indications which are practical guides in judging of the Fertility or Barrenness of the Soil.

Many attempts having been made to explain the productiveness of the soil by chemical or physical causes, without any decided result, it appears desirable to assist the researches of natural philosophers by making them acquainted with those obvious signs, whether of colour, consistence, or vegetation, by which surveyors and farmers are enabled to give at once a practical opinion upon the probable nature of land which they inspect.

IV. AGRICULTURE OF NORFOLK.

FIFTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Report on the present State of the Agriculture of the County of Norfolk :—

stating the ordinary course of cropping adopted in the different soils of the county ; the breeds of cattle, sheep, and pigs most generally bred or fed within it ; the state of its drainage ; the implements used ; the number of horses or other cattle employed in the different operations of husbandry : the tenure on which the farms are generally held ; the wages of labour ; the average amount of the poor's rate ; and whether any and what alterations and improvements have been made in the system of agriculture pursued within it since the Report made to the Board of Agriculture by Arthur Young, which was published in the year 1804, and by Nathaniel Kent, which was published in the year 1796.

V. AGRICULTURE OF CHESHIRE.

FIFTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Report on the present State of the Agriculture of the County of Chester :—

stating the ordinary course of cropping adopted in the different soils of the county ; the breeds of cattle, sheep, and pigs most generally bred or fed within it ; the state of its drainage ; the implements used ; the number of horses or other cattle employed in the different operations of husbandry ; the tenure on which the farms are generally held ; the wages of labour ; the average amount of the poor's rate ; and whether any and what alterations and improvements have been made in the system of agriculture pursued within it since the Report made to the Board of Agriculture by Henry Holland, which was published in the year 1808.

VI. AGRICULTURE OF ESSEX.

FIFTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Report on the present State of the Agriculture of the County of Essex:—

stating the ordinary course of cropping adopted in the different soils of the county; the breeds of cattle, sheep, and pigs most generally bred or fed within it; the state of its drainage; the implements used; the number of horses or other cattle employed in the different operations of husbandry; the tenure on which the farms are generally held; the wages of labour; the average amount of the poor's rate; and whether any and what alterations and improvements have been made in the system of agriculture pursued within it since the Report made to the Board of Agriculture by Arthur Young, the Secretary to the Board, which was published in the years 1807 and 1813.

VII. AGRICULTURE OF WILTSHIRE.

FIFTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Report on the present State of the Agriculture of the County of Wilts:—

stating the ordinary course of cropping adopted in the different soils of the county; the breeds of cattle, sheep, and pigs most generally bred or fed within it; the state of its drainage; the implements used; the number of horses or other cattle employed in the different operations of husbandry; the tenure on which the farms are generally held; the wages of labour; the average amount of the poor's rate; and whether any and what alterations and improvements have been made in the system of agriculture pursued within it since the Report made to the Board of Agriculture by Thomas Davis, which was published in the year 1811.

VIII. IMPROVEMENTS BY WARPING, &c.

TWENTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best account of Improvements made by Artificial Deposits of Soil from the Sea or Tide-Rivers, and the subsequent Cultivation of the land.

IX. KEEPING FARM-HORSES.

TWENTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best account of the way of keeping Farm-Horses in good Condition, both in Winter and Summer.

Competitors must state,—

1. The quantity of food given, and the average cost of such food.
2. The work performed by the horses.
3. The length of time they have been kept on the food described.
4. Whether kept in yards, stables, or pastures.

X. ANY AGRICULTURAL SUBJECT.

TWENTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Essay on any Agricultural Subject.

These Essays must be sent to the Secretary, at 12, Hanover Square, London, on or before March 1st, 1844.

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. That all information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books, or other sources.

2. That drawings, specimens, or models, shall accompany writings requiring them.

3. That all competitors shall transmit a sealed note, containing their names and addresses, with a motto on it to correspond with the one inscribed on the Essay.

4. That the Society shall have the power to publish the whole or any part of the Essays which gain the prizes; and the other Essays will be returned on the application of the writers.

5. That the Society is not bound to give an award, unless they consider one of the Essays worthy of a prize.

6. That, in all reports of experiments, the expenses shall be accurately detailed: that only the imperial weights and measures are those by which calculations are to be made: that prizes may be taken either in money or plate, at the option of the successful candidates; and that no prize be given for any Essay which has already appeared in print.

NOTICE.

It is requested that all communications, addressed to the Society, of experiments on land—whether of draining, liming, manuring, or other operation—be accompanied with the cost of such operation, with the value of the land to rent previous and subsequent thereto, and an analysis of the soil upon which such experiments have taken place; or a specimen of the soil, to be analysed by persons employed by the Society: it is also further requested that, in communications relative to experiments on land in foreign countries, the measures be stated in English values.

Those members who have tried subsoil-ploughing, whether successfully or otherwise, are requested to communicate the result to the Secretary, in the hope that, by comparison of the statements, some judgment may be arrived at as to the soils and situations which are, or are not, suited for this operation.

Distribution of Journal.

LIST OF PERSONS who have consented to deliver the Journals to Members in their neighbourhood on application.

- BEDFORDSHIRE:** *Amphill*, S. Swaffield; *Bedford*, White; *Biggleswade*, S. Sandon; *Dunstable*, E. Butt; *Leighton Buzzard*, W. R. Lawford; *Luton*, J. Wiseman; *Woburn*, C. Burness.
- BERKSHIRE:** *Abingdon*, Parsons; *Bracknell*, Rev. W. L. Rham; *Faringdon*, Knapp; *Hungerford*, Lye; *Isley*, J. Lousley; *Kintbury*, C. Alderman; *Maidenhead*, Tagg; *Newbury*, Roe; *Wallingford*, Payne and Son; *Wantage*, F. Lewis; *Windsor*, Wright; *Wokingham*, Helas.
- BUCKINGHAMSHIRE:** *Aylesbury*, H. Heyward; *Beaconsfield*, E. Bradford; *Buckingham*, Stallworthy; *Chesham*, W. Hepburne; *Colnbrook*, W. Trumper; *Marlow*, G. Cannon; *Great Missenden*, G. Carrington; *Newport-Pagnell*, C. Hanlon; *Stony-Stratford*, W. Nixon; *Winslow*, H. Wigley.
- CAMBRIDGESHIRE:** *Cambridge*, Stevenson; *Chatteris*, H. Skeele; *Ely*, H. R. Evans, Jun.; *March*, L. Reed; *Newmarket*, Bryant; *Shelford*, P. Grain; *Stapleford*, E. Lewis; *Streatham*, T. W. Granger; *Wisbeach*, J. Brown; *Whittlesea*, J. Waddelow.
- CHESHIRE:** *Chester*, Walker and Co.; *Knutsford*, A. Ogilvie; *Macclesfield*, Swinner-ton; *Nantwich*, Griffiths; *Northwich*, Lindop.
- CORNWALL:** *Truro*, Karkeek; *Liskeard*, Bennicke.
- CUMBERLAND:** *Carlisle*, C. Thurman; *Cockermouth*, Bailey and Son; *Maryport*, Maugham; *Penrith*, Brown; *Whitehaven*, Crossthwaite and Co.; *Wigton*, H. Hoodless.
- DERBYSHIRE:** *Alfreton*, G. Coates; *Bakewell*, W. Greaves; *Chesterfield*, J. Atkinson; *Derby*, J. Bromley; *Wirksworth*, Walters.
- DEVONSHIRE:** *Exeter*, Roberts; *Plymouth*, Rowe; *Torrington*, G. Bragington; *Torquay*, A. Johnson Daniell; *Tarstock*, J. Benson; *Tiverton*, T. Parkhouse.
- DORSETSHIRE:** *Blandford*, J. Ilott; *Dorchester*, J. H. Hawkins; *Sherborne*, Toll; *Wareham*, W. R. Fryer; *Wimborne*, Shittler.
- DURHAM:** *Bishop Auckland*, T. Peacock; *Durham*, W. Wetherell; *Stockton-on-Tees*, Jemmett.
- ESSEX:** *Brintree*, Smoothey; *Chelmsford*, Meggy and Chalk; *Coggeshall*, W. F. Hobbs; *Colchester*, Albin; *Dunmow*, D. Carter; *Epping*, R. B. Andrews; *Halstead*, R. Greenwood; *Harlow*, D. Whittaker; *Littlebury*, E. L. Bewsher; *Maldon*, O. Parker; *Ongar*, T. Stokes; *Rayleigh*, H. Cleve; *Rochford*, Syers; *Romford*, Thurlby; *Saffron-Walden*, Secretaries of the Agricultural Society; *Waltham Abbey*, C. Pryor; *Witham*, Butler and Co.
- GLOUCESTERSHIRE:** *Cheltenham*, W. Brown; *Cirencester*, Messrs. Cripps; *Fairford*, D. Trinder; *Forest of Dean*, J. White; *Gloucester*, J. W. Walter; *Lechlade*, J. Dyneley; *Nailsworth*, Partridge; *Newent*, J. Stokes; *Northleach*, D. Trinder; *Stow*, R. Beman; *Stroud*, County of Gloucester Bank; *Tetbury*, D. Trinder; *Tewksbury*, W. Croone.
- HAMPSHIRE:** *Alresford*, Hunt; *Allton*, Lipscombe; *Andover*, Lamb; *Basingstoke*, Cottle; *Bishop's-Waltham*, R. Austin; *Fordingbridge*, G. C. Rawlence; *Isle of Wight*, Rowden; *Lymington*, G. Burrard; *Petersfield*, Wm. Fielder; *Ringwood*, G. C. Rawlence; *Romsey*, W. A. Footner; *Southampton*, Best and Snowden; *Stockbridge*, W. Welton; *Whitechurch*, T. Pain; *Winchester*, Flight.
- HEREFORDSHIRE:** *Bromyard*, Griffiths; *Hay*, Harris; *Hereford*, Fowler; *Ledbury*, J. C. Thackwell; *Leominster*, J. W. Davies; *Ross*, Farror.
- HERTFORDSHIRE:** *Berkhamstead*, T. Dell; *Bishop's-Stortford*, Summers; *Hertford*, E. Lewes; *Hitchin*, Paternoster; *Roydon*, Pickering; *St. Alban's*, John Kinder; *Tring*, William; *Ware*, W. Flack; *Watford*, Niddery.
- HUNTINGDONSHIRE:** *Huntingdon*, C. Margetts; *North Huntingdon*, J. Warsop; *St. Ives*, Rev. J. Linton; *St. Neots*, C. J. Metcalfe, Jun.
- KENT:** *Canterbury*, Champion; *Cranbrook*, Waters; *Bromsgrove*, J. Maund; *Dart-*

ford, Pitman; Dover, H. Boys; Faversham, F. Neame; Foot's Cray, Pitman; Hythe, T. Mount; Maidstone, Wickham; Rochester, J. Oakley; Sandgate, J. Pilcher; Sevenoaks, Col. T. Austen; Sittingbourne, Coulter; Tunbridge, T. P. Charlton; Tunbridge Wells, Nash; Wingham, R. Matson.

LANCASHIRE: *Chorley, A. Bannerman; Lancaster, E. Dawson; Liverpool, W. Skirving; Manchester, J. Dixon; Prescott, R. Earle; Preston, J. Fair; Warrington, Greenall; Wigan, T. Dodd.*

LEICESTERSHIRE: *Ashby-de-la-Zouch, J. Eames; Belvoir, R. Gibson; Hinckley, G. Townsend; Leicester, G. Kilby; Loughborough, J. Buckley; Lutterworth, J. Hind; Market Harborough, Abbott.*

LINCOLNSHIRE: *Barton-on-Humber, Ball; Boston, W. B. Wingate; Bourne, D. Lartett; Folkingham, J. Dunn; Gainsborough, Hall; Grantham, H. Handley; Great-Limber, Gibbons; Horncastle, W. B. Wingate; Kirton-in-Lindsey, J. Booth; Lincoln, J. G. Stevenson; Louth, Rev. H. B. Benson; Market Deeping, V. Stapleton; Market Rasen, W. Farrow; Sleaford, Creasey; Spalding, T. F. Johnson; Spilsby, W. B. Wingate; Stamford, E. E. Dawson; Wragby, W. Pickering.*

MIDDLESEX: *Edmonton, T. Knight; Enfield, J. Meyer; Hounslow, J. Gotelee; Isleworth, W. Warren; Tottenham, J. Dean; Uxbridge, Pullin and Chambers.*

NORFOLK: *Acle, B. Heath; Attleborough, T. Salter; Aylsham, Rev. J. Bulwer; Burnham-Westgate, T. R. Overman; Dereham, Rev. P. Gurdon; Diss, F. Cupiss; Downham-Market, G. Mumford; Fakenham, H. Overman; Great Yarmouth, Sloman; Harleston, R. B. Harvey; Holt, J. Sayers; Larkingford, J. W. Swan; Lynn, Thew; North Walsham, G. Cubett; Northwold, Griffin; Norwich, R. Wright; Stoke Ferry, R. Pigott; Swaffham, Gowing; Thetford, Priest; Watton, T. Barton.*

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NORTHUMBERLAND: *Alnwick, Graham; Dilston, John Grey; Hexham, Pruddeek; Newcastle-on-Tyne, Charnley; Wooler, W. Jobson.*

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OXFORDSHIRE: *Banbury, Stone; Bensington and Dorchester, R. C. Latham; Bicester, W. Paxton; Burford, Tuckwell; Chipping Norton, W. Hitchman; Henley-on-Thames, the Postmaster; Oxford, C. Tawney; Tetworth, W. Lindars; Thame, J. Howlands; Watlington, W. Badcock; Witney, Clinch; Woodstock, W. Margetta.*

Rutlandshire: *Oakham, G. S. Cunnington; Uppingham, G. Daniel.*

SHROPSHIRE: *Bishop's-castle, J. Newitt; Bridgenorth, A. F. Sparkes; Broseley, Pritchard and Co.; Clebury Mortimer, W. Lloyd; Ludlow, R. Jones; Market Drayton, T. Beestone; Much Wenlock, J. Hinton; Newport, Underhill; Oswestry, Price; Shifnal, G. Roden; Shrewsbury, Eddows and Co.; Wellington, J. Stanier; Whitchurch, J. Lee, Jun.*

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STAFFORDSHIRE: *Burton-on-Trent, Darley; Fazeley, E. Farmer; Leek, J. Cruso, jun.; Lichfield, Chawner; Newcastle-under-Lyne, T. W. Mayer; Penkridge, J. Bright; Rugeley, J. T. Walters; Stone, J. Nickisson; Tamworth, E. Farmer; Walsall, W. Harrison; Wolverhampton, G. Ashdown.*

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ISLE OF GUERNSEY: Messrs. De Lisle and Co., 16, Devonshire Square, London.

INDIA: Professor Royle, East India House, London.

BARBADOES: Dr. Ifill, 9, Welbeck Street, Manchester Square, London.

AUSTRALIA: Mr. Henry Manning, 251, High Holborn, London.

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FRANCE: M. Baillière, 219, Regent Street, London.

GERMANY: Mr. Nutt, 158, Fleet Street, London.

Royal Agricultural Society of England.

1843—1844.

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GENERAL REGULATIONS FOR EXHIBITION.

I. No stock can be admitted for exhibition unless the necessary certificates, filled in, on the printed form prescribed, and signed by the exhibitor (or his agent), in the manner directed, shall have been delivered to the Secretary, or sent (postage free), so as to reach the Society's house, No. 12, Hanover Square, London, on or before the 1st of May next for implements, and the 1st of June for all other purposes; after which days respectively no certificates will be accepted. Proper admission-orders, corresponding to the certificates, will be sent to the exhibitors, and be required to be delivered with their animals or articles on presenting them for admission into the Show-yard; when the printed numbers will also be required to be affixed to each animal or article, respectively, by the persons who are in charge of them.

II. The name and residence of the breeder of each animal intended for exhibition, when known, should be stated.

III. Non-members will be required to pay five shillings for every entry of live stock, or assortment of articles for exhibition, before obtaining orders of admission to bring their animals or articles into the Show-yard; and this amount must be remitted by means of post-office order, made payable to the Secretary, and enclosed with the certificate or entry.

IV. The same animal cannot be entered for two classes; and in all cases the age of an animal is to be computed from the day of birth, excepting in the case of horses, when the year only will be required.

V. No animal which won a first prize in any class at any previous meeting of the Society will be allowed to compete for a similar prize at the meeting at Southampton.

VI. The sheep to be exhibited for any of the prizes must have been really and fairly shorn between the 1st of May and the 1st of July, 1844, both days inclusive.

VII. All animals intended to be exhibited as Extra Stock must be duly entered on the printed forms, as in the cases of animals to be shown in the classes.

VIII. Any person who shall have been proved, to the satisfaction of the Council, to have been excluded from showing for prizes at the exhibition of any society in consequence of having been convicted of an attempt to obtain a prize by giving a false certificate, shall not be allowed to compete for any of the prizes offered by the Royal Agricultural Society of England.

IX. In case any gentleman, or number of gentlemen, wish to offer a prize for any class of stock not distinctly specified among the prizes offered by the Society, he or they will be allowed to offer such prize at the meeting at Southampton; and the stock which shall compete for such prize shall be exhibited, subject to such conditions as shall be decided upon by the Council; and the prize awarded by such of the judges as the Council shall select. Animals exhibited for such prizes shall not be prevented from competing for any of the prizes offered by the Society for which they are qualified.

X. Stock of every description can only be admitted into the Show-yard on the presentation with them of the proper orders, and between the hours of eight in the morning and four in the afternoon, on Tuesday the 23rd of July; and must remain in the Show-yard until after six o'clock in the afternoon of Thursday the 25th of July; and no animal can be removed from its place, or taken out of the Show-yard, without leave in writing from the Director or Stewards; nor will they be allowed to be removed from the yard until after ten o'clock on the morning of Friday the 26th of July, without leave in writing from the Director or Stewards of the yard, with the exception of Stallions only, which may be removed for the night.

XI. Persons intending to exhibit Seed-Wheat or Barley, Implements, Seeds, Roots, &c., must send in their certificates to the Secretary of the Society, in Hanover Square, London, on or before the 1st of May for implements, and the 1st of June for other articles of exhibition; and furnish him with a description (written on one side only of the certificate) of the articles intended to be shown, and the probable space which may be required for them (bearing in mind that the sheds are only 20 feet wide), in order that the Director may be enabled properly to apportion the space allotted for the exhibition of such articles among the various parties making application; and the articles to be exhibited must be brought to the Show-yard before nine o'clock on the evening of Thursday, July 18th, as none will be admitted after that day and hour.

XII. Whenever reference is made to weights and measures, it is to be considered that the imperial weights and measures only are referred to.

XIII. The Judges of Stock are to have the whole of Wednesday the 24th of July for making their adjudication, and signing their award; and the Director and Stewards are instructed to take care that no Governor or Member (including the Council), stranger or competitor, be admitted, under any pretence whatever, into the yard on that day.

XIV. No prize will be given when the Judges shall be of opinion that there is not sufficient merit in the stock, implements, &c., to justify an award.

XV. All persons admitted into the Show-yard shall be subject to the rules, orders, and regulations of the Council.

* * Further information respecting regulations of detail may be obtained from the Secretary, at No. 12, Hanover Square, London.

EXTRA STOCK.

Persons intending to exhibit animals as Extra Stock can alter the blank Certificates to answer their purpose.

A SALE BY AUCTION, of Stock and other articles exhibited at the Meeting, will take place in the Show-yard, on the morning of Friday, the 26th of July, at ten o'clock precisely, the Society paying the Auctioneer for his attendance on the occasion. Exhibitors intending to offer Stock or other articles for sale must give notice on their Certificates at the time of their entry; and no person will be allowed to withdraw such entries of sale by auction, unless on paying a forfeit of Five Shillings

for each entry of live stock, or assortment of articles for exhibition. The Regulations and Conditions of the sale will be published for the information of Exhibitors previously to the 1st of June.

INSTRUCTIONS TO THE JUDGES.

As the object of the Society in giving the prizes for neat cattle, sheep, and pigs, is to promote improvement in breeding stock, the Judges, in making their award, are instructed not to take into their consideration the present value to the butcher of animals exhibited, but to decide according to their relative merits for the purpose of breeding.

In the Class for horses, the Judges, in awarding the prizes, are instructed, in addition to symmetry, to take activity and strength into their consideration.

ESSAYS AND REPORTS ON VARIOUS SUBJECTS.

Prizes for 1844.

PRIZE ESSAYS.

I. WATER-MEADOWS AND UPLAND PASTURES.

TWENTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Account of the Comparative Value of Water-meadows and Uplands generally for Cattle, Sheep, and Horses, but especially for Milch Cows.

Competitors will be required to state the following particulars in reference to the trials instituted for the purpose of obtaining practical results on this subject:—

1. The nature of the soil and its state of drainage to be described; and equal portions of upland and water meadow to be selected.
2. Equal numbers of cows of the same age and breed (not less than four in number) to be separately fed in pairs, on each different kind of grass, and to be changed once from one kind of grass to the other; and the quantity, as well as the quality, of the milk from such cows to be ascertained by the lactometer.
3. If made into hay, the quantity of each sort produced on the land, and the quantity, as well as quality, of the milk which has been produced, to be ascertained in a similar manner.
4. The value of spring food and grass, whether in rowen or pasture.
5. The same conditions to be applicable to the feeding of sheep-stock; stating the numbers which the same quantity of each land has separately maintained during a certain period; and whether or not subject to the rot by the flooding.
6. In regard to irrigating the land: the primary cost, whether of catch-water or flow-meadow, of its formation, and the annual expense of management, including the repair of sluices; together with the former and present rent or value.

Competitors are also requested to state, as far as their observation may have extended, the comparative value of the grasses of water-meadows and uplands, when cut into hay, and consumed as fodder.

II. INFLUENCE OF CLIMATE.

TWENTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Essay on the Influence of Climate upon Cultivation within the limits of Great Britain and Ireland.

There being good reason to suppose that the discordant practices of farming in different districts may be partly attributed to the influence of climate, competitors for this prize must endeavour to describe those practices, and to trace them to the variation of climate.

Under the term climate must be included the degree of cold or heat, moisture or drought, arising whether from latitude, elevation, neighbourhood to or distance from the sea, &c.

Variation in practice may be looked for in the management of artificial and natural grass, the growth of root-crops, the depth of ploughing, the time of sowing, the choice of white crops, &c.

III. INDICATIONS OF FERTILITY OR BARRENNESS.

FIFTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Essay on the Indications which are practical guides in judging of the Fertility or Barrenness of the Soil.

Many attempts having been made to explain the productiveness of the soil by chemical or physical causes, without any decided result, it appears desirable to assist the researches of natural philosophers by making them acquainted with those obvious signs, whether of colour, consistence, or vegetation, by which surveyors and farmers are enabled to give at once a practical opinion upon the probable nature of land which they inspect.

IV. AGRICULTURE OF NORFOLK.

FIFTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Report on the present State of the Agriculture of the County of Norfolk:—

Stating the ordinary course of cropping adopted in the different soils of the county; the breeds of cattle, sheep, and pigs most generally bred or fed within it; the state of its drainage; the implements used; the number of horses or other cattle employed in the different operations of husbandry; the tenure on which the farms are generally held; the wages of labour; the average amount of the poor's rate; and whether any and what alterations and improvements have been made in the system of agriculture pursued within it since the Report made to the Board of Agriculture by Arthur Young, which was published in the year 1804, and by Nathaniel Kent, which was published in the year 1796.

V. AGRICULTURE OF CHESHIRE.

FIFTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Report on the present State of the Agriculture of the County of Chester:—

Stating the ordinary course of cropping adopted in the different soils of the county; the breeds of cattle, sheep, and pigs most generally bred or fed within it; the state of its drainage; the implements used; the number of horses or other cattle employed in the different operations of husbandry; the tenure on which the farms are generally held; the wages of labour; the average amount of the poor's rate; and whether any and what alterations and improvements have been made in the system of agriculture pursued within it since the Report made to the Board of Agriculture by Henry Holland, which was published in the year 1808.

VI. AGRICULTURE OF ESSEX.

FIFTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Report on the present State of the Agriculture of the County of Essex:—

Stating the ordinary course of cropping adopted in the different soils of the county; the breeds of cattle, sheep, and pigs most generally bred or fed within it; the state of its drainage; the implements used; the number of horses or other cattle employed in the different operations of husbandry; the tenure on which the farms are generally held; the wages of labour; the average amount of the poor's rate; and whether any and what alterations and improvements have been made in the system of agriculture pursued within it since the Report made to the Board of Agriculture by Arthur Young, the Secretary to the Board, which was published in the years 1807 and 1813.

VII. AGRICULTURE OF WILTSHIRE.

FIFTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Report on the present State of the Agriculture of the County of Wilts:—

Stating the ordinary course of cropping adopted in the different soils of the county; the breeds of cattle, sheep, and pigs most generally bred or fed within it; the state of its drainage; the implements used; the number of horses or other cattle employed in the different operations of husbandry; the tenure on which the farms are generally held; the wages of labour; the average amount of the poor's rate; and whether any and what alterations and improvements have been made in the system of agriculture pursued within it since the Report made to the Board of Agriculture by Thomas Davis, which was published in the year 1811.

VIII. IMPROVEMENTS BY WARPING, &c.

TWENTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best account of Improvements made by Artificial Deposits of Soil from the Sea or Tide-Rivers, and the subsequent Cultivation of the land.

IX. KEEPING FARM-HORSES.

TWENTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best account of the way of keeping Farm-Horses in good Condition, both in Winter and Summer.

Competitors must state,—

1. The quantity of food given, and the average cost of such food.
2. The work performed by the horses.
3. The length of time they have been kept on the food described.
4. Whether kept in yards, stables, or pastures.

X. ANY AGRICULTURAL SUBJECT.

TWENTY SOVEREIGNS, or a Piece of Plate of that value, will be given for the best Essay on any Agricultural Subject.

These Essays must be sent to the Secretary, at 12, Hanover Square, London, on or before March 1st, 1844.

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. That all information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books, or other sources.

2. That drawings, specimens, or models, shall accompany writings requiring them.

3. That all competitors shall transmit a sealed note, containing their names and addresses, with a motto on it to correspond with the one inscribed on the Essay.

4. That the Society shall have the power to publish the whole or any part of the Essays which gain the prizes; and the other Essays will be returned on the application of the writers.

5. That the Society is not bound to give an award, unless they consider one of the Essays worthy of a prize.

6. That, in all reports of experiments, the expenses shall be accurately detailed: that only the imperial weights and measures are those by which calculations are to be made: that prizes may be taken either in money or plate, at the option of the successful candidates; and that no prize be given for any Essay which has already appeared in print.

NOTICE.

It is requested that all communications, addressed to the Society, of experiments on land—whether of draining, liming, manuring, or other operation—be accompanied with the cost of such operation, with the value of the land to rent previous and subsequent thereto, and an analysis of the soil upon which such experiments have taken place; or a specimen of the soil, to be analysed by persons employed by the Society: it is also further requested that, in communications relative to experiments on land in foreign countries, the measures be stated in English values.

Those members who have tried subsoil-ploughing, whether successfully or otherwise, are requested to communicate the result to the Secretary, in the hope that, by comparison of the statements, some judgment may be arrived at as to the soils and situations which are, or are not, suited for this operation.

JOURNAL

OF THE

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

I.—*On Farm-Buildings.* By JOHN GREY.

THERE are many steps in the scale of agricultural improvement which are accessible to the tenant alone, and which it is his peculiar and bounden duty to avail himself of; but there is one, and that of primary importance, as regards the means of carrying out many others with effect, and on which indeed the successful management of a farm must in great measure depend—in which the landlord's interest is materially concerned, and which it belongs to him unquestionably to provide for the tenant—and that is suitable and convenient accommodation for the farmer himself, for his labourers, and for his cattle.

No one can have travelled much in the rural districts of England, even in those which are comparatively well cultivated, without being struck, if he have any sense of neatness and order, with the ill-arranged and patch-work appearance of many of the farm-buildings, which are often placed, in relation to their different parts, in utter defiance of the economy of labour in the case of the cattle; and, what is still worse, with little regard to the production and preservation of the manure, the dry parts of which may be seen exposed to the winds, and the liquid part carried off without being applied to any beneficial purpose. In some the practice still prevails—the unnatural practice, I must call it—of tying up cattle intended to be fattened for the market to stakes, from which they are never released till they are driven off to the butcher—denied all the time the natural use of their limbs, the choice of their position in lying down, and the means of varying the atmosphere in which they are confined—a matter in which cattle are peculiarly discriminating and sensitive. When, at length, set at liberty to perform a weary journey to their place

of execution, they are seen suffering in their bodies from exposure, and in their limbs from the unwonted exertion of walking, with their feet bruised and swollen to such a degree that the hoofs sometimes come off altogether. And in another part of the same offices a younger set of cattle may be found without sufficient shelter and protection to secure their health and comfort.

As far as my observation goes, it is not on the estates of the resident country gentlemen, even those of moderate incomes, that the greatest deficiency in good farm-buildings is to be found; but chiefly on the very large estates of the wealthiest landowners—which may appear rather paradoxical. Is it that they are so little informed on the subject as not to know that such accommodation is necessary to its profitable occupation by their tenants? In such cases (and of such some examples may be found), the farmsteads near the residence, or near the roads approaching to it, may obtain some attention; but the remote ones are left to their fate. Now where the owners are so indifferent to the condition of their property, the agents are not likely to be very forward to incur their displeasure, and bring labour upon themselves, by urging the necessity of a troublesome and expensive reform. It is not indeed to be expected that a taste for rural pursuits, and an inclination for agricultural improvement, should incite many noblemen to follow in the useful and patriotic path of the Duke of Bedford, Lord Leicester, and Lord Spencer; or that the liberal and prudent, and in the end most economical, course which has been pursued by the Earl of Lonsdale, in Westmoreland, Sir James Graham, in Cumberland, and Earl Grey, in Northumberland, should be followed by all landlords: but it may be hoped that good example, and the general course of improvement, will at length force themselves on the attention of the most careless. The last named and excellent landlord has most wisely supplied each farm on his fine estate, as it fell out of lease, with substantial buildings, so that it is now nearly complete in that respect, and is a pattern of good management to the country. Whereas others, by doing nothing, or as little as possible, are only procrastinating the evil day which must come at last, with overwhelming cost; and in the meantime are suffering an annual depreciation of their property.* Could the landlords hear now and then the discussions on their management which take place among the farmers around them, they might obtain useful hints for their own benefit.

* One of the most interesting and remarkable instances of improvement that has come under my notice has been effected by the munificent and judicious encouragement given to it by Mr. Clifton, of Lytham, on his extensive estate, under the direction of his energetic agent, Mr. Fair, by which the hitherto very backward district of the Fyld in Lancashire has, in a very few years, risen to a state of agricultural importance.

Let a stranger ask of them the question, "How is it that so many of you are anxious to become tenants upon such an estate, in preference to some others; and that you offer such high rents for those farms?" and he would receive some such reply as this:—"There is a mighty difference: the one has a commodious farmhouse, in which my family could enjoy comfort; and excellent offices, so that I could make the most of my cattle, and keep my horses in good health and condition. The other has little that is good about it—a bad house, in which my wife and daughters would never be content; bad buildings, which will not protect my cattle from rain and snow; cottages so bad that no good servants will remain in them; and all these to be patched and propped yearly by the tenant, for the landlord will do nothing." A mighty difference, truly: no wonder that the worst tenants, the worst peasantry, and the worst management are found on such estates. It happened to myself lately, in passing along a road which leads through the estate of a wealthy landlord, to meet the tenant, a respectable man and good farmer, occupying a large farm. I entered into conversation with him, in the course of which he told me that he had brought a new bull from a distance, and wished much that I would ride down to the farm, and give him my opinion of him. I readily consented to this, and applauded his spirit for introducing a good animal into the neighbourhood. When we reached the place, I found the offices, with few exceptions, in a ruinous condition. He said the bull was in a house in the corner of a fold-yard: when we reached it, the house was partly down, and the bull had escaped. "Aye," said the farmer, "he's gone again; he often breaks out—he's like Samson—he carries off door and posts and a lump of the wall at once; all our place is so bad that we have not a house that will hold him." We, however, found "Lord Brougham" careering among some young cattle in an adjoining field, and a creditable animal he was, and deserving of better lodgings. Many similar specimens of farm-buildings might be referred to: yet the tenants, if a fair length of lease were granted, would incur the expense—and that is no inconsiderable proportion of the whole—of bringing to the spot all the materials required in constructing new ones.

The object of this paper is to endeavour to point out the advantage of having good farm-offices, and the points to be aimed at in their construction—namely, convenience, accommodation, and economy; economy, not only in their first erection, but in the future saving of labour, arising from a compact form and good arrangement: such, for instance, as having the barn, straw-house, and turnip-stores centrally situated, and affording easy access to fold-yards; the sheds suitably arranged for the accommodation of

cattle of different ages; and the stables for draught horses, the shed for carts and implements, and the joiner's and smith's shops placed conveniently for each other. It is no doubt much easier to construct an entirely new set of offices upon an approved plan than to fit in, with due attention to convenience, a part that is new with some other which is thought to be worth preserving; and the result of such attempts often is a regret that the old had not been given up altogether. It is, however, possible, in many cases, where a desire to save some part of the present buildings exists, to form the new upon such a plan as may be filled up and completed whenever the time comes that the old part shall be considered bad enough to be removed. It is necessary that I should refer here to certain objects which must claim the attention of every one in fixing the site of farm-building, and which I have already enumerated elsewhere*—such as being central to the tillage-land, accessible by easy roads, commanding a supply of water for the use of stock, and for the working of machinery, if possible, &c. &c.; and probably the best service I can render to the Society, in endeavouring to comply with a request which has been made to me to contribute to its Journal an Article upon farm-buildings, will be to furnish it with some plans of offices, of different dimensions, which may be extended or reduced at pleasure, to suit the size of farms and the amount of accommodation required. An examination of those plans will show much better than any verbal description the objects which I think ought to be combined in the construction of farm-offices. No. 1 represents such offices as have been recently erected on the estates in this county which are the most distinguished by good buildings—viz., those of the Greenwich Hospital, Earl Grey, Sir John Swinburne, Mr. Baker, M.P., Mr. Ord, M.P., Mr. Bigge, Mr. Carr, &c.—without professing to be an exact copy of any. Nos. 2 and 3 represent offices on the Greenwich Hospital estates; and No. 4 a very extensive set of offices now being erected on a farm the property of the Duke of Roxburgh, situated on the border of that county where it joins Northumberland, with which his Grace's agent has kindly supplied me. The extent of that farm is 1170 acres, and the rent 2600*l.* per annum. It will seen from these plans that the corn is all threshed by machinery, worked by steam, water, or horse power—that it is all stacked in a yard adjoining the barn—that one barn suffices for the largest farm—that the barn and straw-house occupy the centre of the north side of the square—that the straw-house (except in No. 3, which is a great objection to that plan) is placed at right angles to the barn, and

* See Article on the 'State of Agriculture in Northumberland,' vol. ii., part 2, in the Journal.

the straw is delivered from the threshing-machine into the middle of it, and is therefrom conveyed to each end to be built up, with less labour than if the house stood lengthwise in a line with the barn, by which means, too, different kinds of straw may be placed in the opposite ends, and got at easily from the open space in the centre—that the cattle are all disposed in folds, open to the south, but sheltered from the other points with a court and shed, so that they can enjoy air and sunshine when the weather is mild, and retire under cover when stormy, which privilege they are quick to avail themselves of—that no provision is made for tying up any cattle but the milch cows, and as it is not at all a dairy county those are only kept for domestic use and the rearing of calves, and are few in number*—that the granaries are placed above the open sheds, as being the driest (for corn never keeps well in granaries where cattle are confined below them), and also as being the most convenient from their vicinity to the barn, from which the corn is carried without being taken out of doors, or is drawn up by tackle attached to the machinery, and from which it can be loaded into carts with great ease by trap-doors in the floor, corresponding with the arches below.

I am aware that this arrangement of offices will not be approved of in all its parts in those districts of England where it is thought necessary to house the corn and to stall-feed the oxen, and where the flail is exclusively used in the operation of threshing. I am also aware of the difficulty of overcoming long-established habits and deep-rooted prejudices, and have had some experience of the impolicy of attempting to do so too rashly; yet, in so serious an outlay as the erection of farm-offices involves, it well deserves the consideration of landlords, whether they should not attempt to find a substitute for the very expensive and very unsightly barns which encumber the farms in many of the southern counties, and the desire for which fills with astonishment our northern farmers, who see in them a source of needless expenditure in building and repairs, a harbour for vermin, a great addition to the danger and destructiveness of fire, and a periodical robbery from the farm of part of its manure for thatching, for the purpose of perpetuating the tedious and expensive mode of threshing by hand instead of by machinery. It will be seen, by reference to plan No. 4, that one barn suffices for a farm of tillage-land on the Tweed, for which a rent of 2600*l.* is paid; and I am confident that, if the intelligent and energetic tenant of that farm were offered by his landlord as many more barns as would be thought requisite upon a farm of equal extent in the south of England, he would receive

* For rearing of calves and fattening of cattle, see the Article on 'Northumberland Agriculture,' vol. ii, part 2, in the Journal, under the head of 'Cattle.'

the offer with wonder, and reject it with derision. I imagine, too, that a tenant on an equal scale in the south would find a strong temptation thrown in his way to abandon his eight or ten flails, and to adopt the system of the north, if his landlord were to propose to him that, instead of the expense being incurred of building a great many barns, he should hold with one adapted to a threshing-machine, and should have all the money that would thus be saved to lay out in any improvement such as his farm might particularly require—whether furrow-draining, subsoil-ploughing, embanking, irrigating, or manuring; any of which would probably soon repay the outlay, with interest—whereas the other is a constant drain in the shape of repairs.

I am not certain that I am acquainted with all the arguments that may be adduced in favour of the flail practice by those who retain it; but such as I know I shall remark upon. A very strong one, however, on the other side may here be mentioned, and it is of sufficient power, if well founded, to overturn all the others; which is, that the extra quantity of grain obtained by the threshing of a powerful machine over that by flails is equal, with fair prices, to repay the entire expense of the operation. I have heard it said by occupiers of land in the south of England, that if they were to adopt our plan they should not know how to dispose of their threshers, who are not dexterous workmen in other branches, and might be thrown on the parish. This reason appears to me to be extremely futile and ridiculous; for I have never yet seen the farm of tolerable extent on which a few extra hands could not be employed during the winter months to advantage, in operations where great dexterity is not required, such as draining, scouring ditches, improving fences, making compost, repairing or levelling roads, &c. &c., in which, without being turned to the parish workhouse, such men could be occupied until they should find something more to their minds elsewhere, and become absorbed in the mass of the working population. Besides, the introduction of machinery does not diminish the requisite number of hands to be employed, although it alters their character and occupation. I know nothing better calculated to preserve the vacant mind in a state of stationary vacuity than the sober sameness of the flail's evolutions from morn to night, and from week to week; but the man who wields the flail by mere animal strength must undergo much cultivation, and be greatly elevated in mind and acquirements, ere he can become the machine-maker, to calculate its motions and adjust its parts; and even the farm-servant in whose charge the machine is placed, after a short training by the millwright, is called upon to exercise a superior degree of intelligence and attention in equalizing the steam, if that power be used, and in regulating the operations in any circumstances.

In so far, then, it would have the effect of substituting a superior class of operatives to that which had been dismissed by the change. Besides which, when the machine is at work some hands are wanted to cart the unthreshed corn to the barn, if the stack be distant, or to wheel it in on canvass barrows, as the seed-crops are collected in Holland, if it be near. Several women and boys are employed to loosen the sheaves and hand them to the man at the feeding-board, while others are busied in piling up the straw and dressing and measuring the corn; and thus, although quite different in kind, much occupation is given to various classes of people, who, otherwise, might not have the opportunity of doing much for the relief of their families. One comfort, too, for the farmer attends this mode of proceeding: when the threshing is done, and the corn dressed up, the machine is at rest probably for some days, and his barn is locked up; whereas, with half a dozen barns, occupied by men threshing daily with flails, his property is always exposed to pilfering and depredation. Besides, a good machine enables the farmer to thresh a quantity of grain at once, to meet a call upon him for money, to take advantage of a good price, or to provide seed; and gives him the means of employing people in the time of frost and snow, so as to have them at liberty for field-labour when wanted. Another objection to the threshing-machine, which I have heard of, is that it bruises the straw too much. There may be something in this, where straw is to be sold in the London market, or used for thatching houses, which use of it cannot be too soon abolished as an extravagant and wasteful practice—at least, so long as the slate quarries of Wales and Westmoreland afford in such abundance a covering at once light, durable, and economical—but, for food, or litter in cattle-sheds, this can be no objection: while, on the other hand, implements for chopping straw or hay may be worked by being attached to the threshing-machine, with less expense than in any other way.* It is probable that the straw of the northern counties does not break under the operation of the threshing-machine so much as that of the south, because the custom does not prevail here of allowing the corn to stand uncut until it becomes dead ripe and sunburnt—a custom which is of very doubtful expediency, as grain makes better seed, and is found to yield more meal, when cut before it attains its last stage of ripeness, and the straw is unquestionably better for all purposes. Besides, it does not injure the working of the threshing-machine, instead of having both rollers fluted, to make the upper one solid and smooth, by which means the straw is less broken. The upper roller is so easily changed,

* The erection of a steam-engine affords a good opportunity for constructing an apparatus for steaming potatoes and other food for cattle.

that it is advisable to have one fluted and another plain, to apply as circumstances may require. There is a newly-invented threshing-machine, which works by what is called a *patent peg-drum*, instead of the flanged drum and rollers, which is said not to break the straw at all, and in other respects to perform its work admirably, and with a saving of one-third of the power—in which case four horses will do the work of six; but not having seen it in operation, I can only speak from report. I have heard also that some maltsters in the south give a preference to barley threshed by flail—the reason for which I never heard assigned; and it is notorious that in this county, and those of the south of Scotland, hardly any other is used but what is threshed by machines, and no objection is ever made to it. It is possible that grain may be bruised in threshing, or broken off so close at the end as to injure its germinal powers; but that must arise, I imagine, rather from some defect in particular machines than from any fault generally applicable to the system. On the other hand, however, it is an established fact, that, in the markets of the north, wheat threshed by machinery commands a higher price by some shillings per quarter than that threshed by flail, and for this obvious reason:—take two stacks of wheat, equal in quality and condition; let one of them be taken in and put through the machine, and the grain is dressed up and sacked before night; let the other be put, on the same day, into a barn to be threshed by flail—it takes a man a fortnight to knock out the corn very imperfectly, and each night the produce of the day is added to the heap till all is finished: this heap consists of chaff and grain, resting all the time on a ground-floor, and though the floor be perfectly dry, yet the grain is said to acquire, if not actual dampness, still a degree of toughness, in grinding which any miller can detect; hence arises his objection, and the difference in the price he offers.

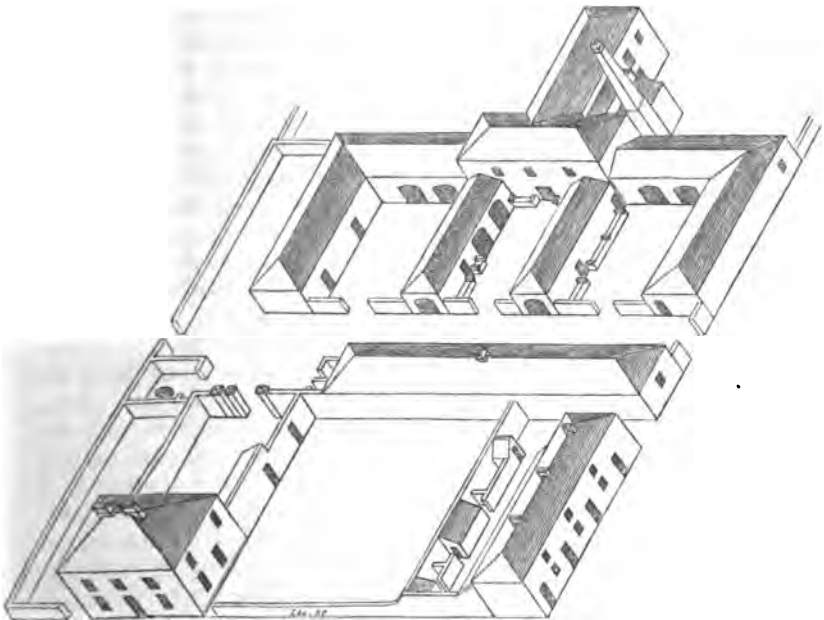
The buildings described in the annexed plans are of stone-masonry, well roofed with Memel timber, and covered with the best Welsh slate. It might seem desirable to give an idea of the cost of such buildings, but it is impossible to do so with any degree of correctness, owing to the great difference that frequently exists between one locality and another in the kind and quality of building materials, and the distance at which they are to be procured; but any landlord, wishing to build a set of offices, can at any time ascertain what the expense would be to him, by first laying down his plan, and taking in estimates for the work.

My friend Mr. Nash informs me that four large barns on the property in Cambridgeshire which is in his own occupation, consisting of 1030 acres, of which 850 are under the plough, would cost in building 2400*l.*, besides some fitting up with boards and threshing-floors. According to the system pursued in the border

counties, and set forth in the accompanying plans, a barn and straw-house for a stationary threshing-machine would be built even in that county, where building is very costly from want of stones, for at most 600*l.*; leaving a saving of nearly 2000*l.* on the original outlay, besides the annual loss of interest upon that large sum, and the cost for repairs and insurance.

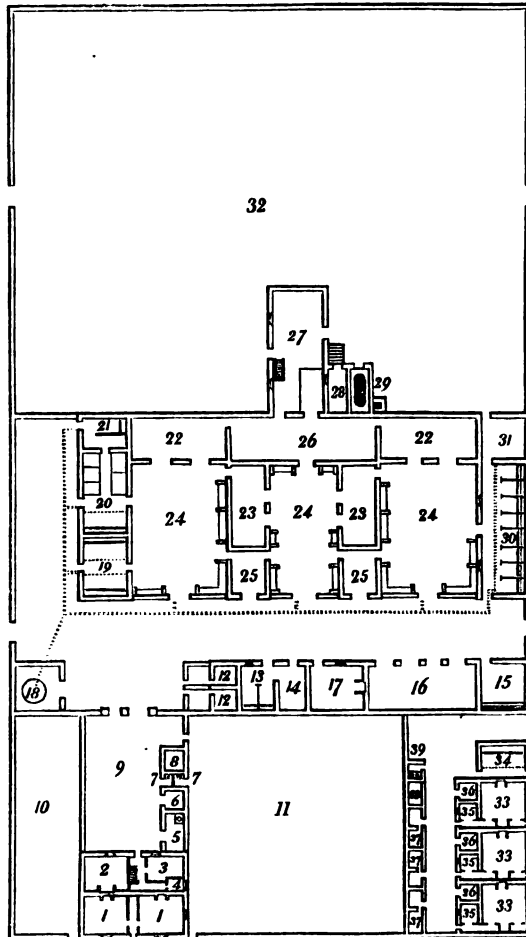
Dilston, Jan. 12, 1843.

AN ISOMETRICAL PROJECTION of the FARM-HOUSE and FARMERY represented in Plan No. 1.



**GROUND PLAN of a FARM-HOUSE and FARMERY of FOUR PLOUGHS, TEN COWS, and from
TWENTY-FIVE to THIRTY YOUNG CATTLE.**

No. 1.



ACCOMMODATION.

The Farm-House contains—

1. Two Parlours.
2. A Kitchen.
- 3, 4. Dairy and Pantry.
5. Washing-Shed.
6. Coal-House.
7. Two Privies.
8. Ash-Pit.
9. Yard.
10. Shrubby, or
11. Garden.

The Farmery contains—

12. Two Pig-Houses.
13. Riding-Stable.
14. Loose Box.
15. Foal-House.
16. Cart-Shed.
17. Smithy.
18. Cesspool.
- 19, 20. Byers and Calf-House.
21. Bull-House.
22. Two Feeding Cattle-Sheds.
23. Sheds for Year-old Cattle.
24. Folds.
25. Two Turnip-Houses.
26. Straw-Barn.

27. Corn-Barn.

- 28, 29. Engine and Engine-Boller Houses, or Water on Horse Wheel.

30. Stable.

31. Hay-House.

32. Stack-Yard.

33. Three Cottages for Farm-Labourers.

34. Cottager's Cow-Byer.

35. Cottage-Pantries.

36. ——— Coal-Houses.

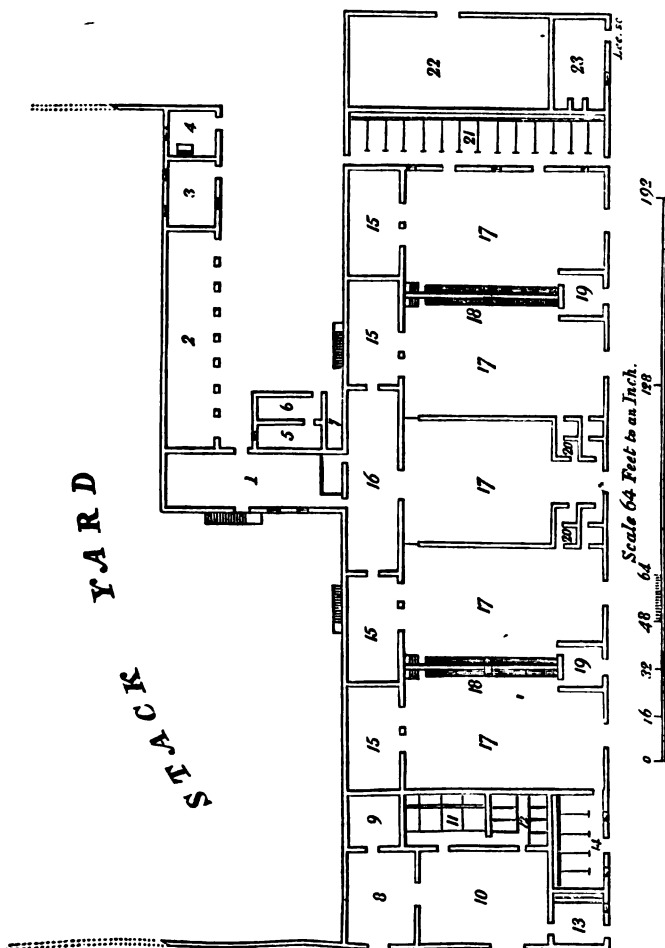
37. ——— Pig-Houses.

38. ——— Ash-Pit.

39. ——— Privy.

GROUND PLAN of FARM-BUILDINGS at
 OUTCHESTER, containing 511 Acres;
 Rent, £772.

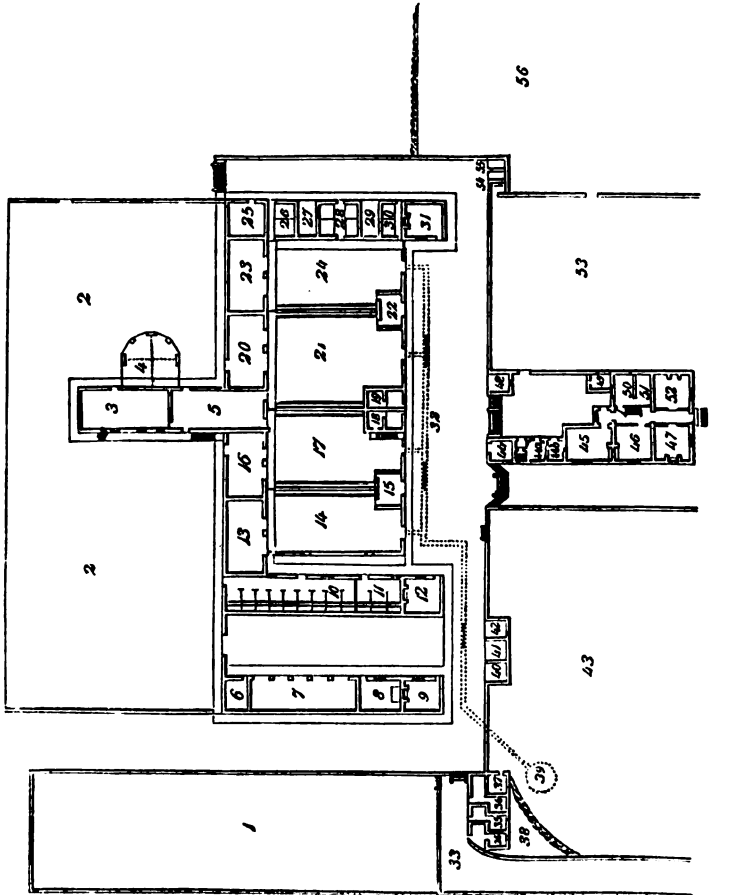
No. 2.



1. Threshing-Barn, with Dressing-Floor below.
2. Cart-Shed.
3. Cartwright's Shop.
4. Blacksmith's Shop.
5. Steam-Engine.
6. Coal-House.
7. Well.
8. Fold.
9. Built-House.
10. Fold for Cows.
11. Byre.
12. Calf-House.
13. Loose Box.
14. Saddle-Stable.
15. Hovel, with Granary above.
16. Straw-Barn.
17. Fold.
18. Turnip-Cribs.
19. ——— House.
20. Pigsties.
21. Cart-Horse Stable.
22. Hay-Yard.
23. Out-House, for the accommodation of Reapers, &c.

FARM-OFFICES at THROCKLEY, near Newcastle-upon-Tyne, belonging to the Commissioners of Greenwich Hospital.—ACRES, 340.—RENT, £540.

No. 3.



- | | |
|--------------------------------|-----------------------|
| 1. Cottager's Garden. | 37. Turnips. |
| 2. Stack-Yard. | 38. Byer. |
| 3. Corn-Barn. | 39. Turnips. |
| 4. Engine-House. | 30. Byer. |
| 5. Straw-House. | 31. Cottage. |
| 6. Tools. | 32. Main Drain. |
| 7. Carts. | 33. Lane. |
| 8. Smith. | 34, 35, 36. Pigs. |
| 9. Cottage. | 37. Duck-House. |
| 10. Stable. | 38. Plantation. |
| 11. Saddle-Horses. | 39. Cesspool. |
| 12. Cottage. | 40. Cottager's Coals. |
| 13. Hemel, with Granary above. | 41. Ashes. |
| 14. Fold. | 42. Coals. |
| 15. Turnips. | 43. Calf-Close. |
| 16. Hemel, with Granary above. | 44. Gigs. |
| 17. Fold. | 44a. Ashes. |
| 18, 19. Figs. | 44b. Coals. |
| 20. Hemel, with Granary above. | 45, 46. Kitchens. |
| 21. Fold. | 47. ParLOUR. |
| 22. Turnips. | 48. Oven-House. |
| 23. Hemel, with Granary above. | 49. Churn-House. |
| 24. Fold. | 50. Dairy. |
| 25. Bull. | 51. Pantry. |
| 26. Byer. | 52. Drawing Room. |
| | 53. Garden. |
| | 54. Cottager's Ashes. |
| | 55. Coals. |
| | 56. Plantation. |

ON THE ESTATE OF
HIS GRACE THE DUKE OF ROXBURGHE.

1842.

No. 4.



1. Cattle-Shed.
2. Cattle-Shed, with Granary above.
3. Yard.
4. Turnip-Crib.
5. Turnip-Store.
6. Wood-Yard.

7. Smi
8. Smi
9. Joir
10. Too
11. Res
12. Car

II.—*Account of the Tussac Grass (Dactylis cespitosa) growing on Peat Bogs in the Falkland Islands.*

[From Dispatches of Lieut.-Governor Moody to Lord Stanley.]

THERE is another indigenous grass of inestimable value, which deserves the particular attention of every person connected with grazing and sheep-farming even in England, but more especially Scotland and Ireland. I allude to what is here called "Tussac." The tussac is a gigantic sedgy grass, of the genus *Carex*. I measured the length of the blades, and found them to average seven feet in length, and three quarters of an inch in width; some, in favourable situations, are longer, and if cultivated with care they would probably flourish still more vigorously. The plants grow in bunches close together, and as many as 250 roots spring from one bunch. In old plants the decayed roots of successive shoots form a cushion of dry entangled fibres, which raise the bunch from the ground. This cushion sometimes attains to a great size and height, so that a person standing in a patch of old tussac may be quite sheltered and concealed. The cushion is dry and inflammable; and where the wild cattle and horses have completely destroyed the plants by eating down to the very roots inclusive, these lumpy accumulations of decayed fibres are left encumbering the ground with a multitude of hummocks, easily removed, however, by fire.

The grass growing in large tufts upon the high base of decayed roots resembles, at a distance, a diminutive grove of thickly-clustered palms; and from the dark green and luxuriant appearance given to the smaller islands clothed with tussac, the richness of tropical vegetation is forcibly recalled to the memory.

All the other species of the genus *Carex* are described in botanical works as coarse and rank, and by no means adapted for fodder, but it is very different indeed with this species. That it is sweet-flavoured, tender, and most nourishing, is evident from the avidity with which all animals feed, and the rapidity with which they fatten upon it—cattle, horses, sheep, and pigs alike. For about three or four inches the roots are very agreeable to man, being crisp, and of a sweetish nutty flavour, very much resembling the heart of the palm-tree in the West Indies, which is called the mountain cabbage.

There is an island close to the settlement which is fringed with the tussac grass for a breadth of about 200 to 300 yards, the remaining portion being wiry coarse grass and moss on wet land. Lean cattle turned upon this island become fat in two or three months; and the miserable old horses that return from the cattle-

hunting expeditions dreadfully out of condition, soon pick up, and become quite fat upon the tussac which grows there.

The two Americans who wandered upon West Falkland for 14 months lived upon the root daily, and formed their huts of what I have termed the cushion, rolling one to the small doorway or opening when night came on.

The long blades of the grass make but an indifferent thatch, as it is much too brittle to last when dry: there are no fibres sufficiently tough or coarse for this purpose. I may notice that cattle and horses will readily eat dry tussac when they cannot procure it fresh; but an ample supply of it can always be obtained, as it is green and luxuriant all the year round.

The bounty of Providence causes this extremely nutritious grass to grow most luxuriantly in the rank peat-bogs by the sea-shore, where any other, even of the most inferior quality, could scarcely live. I may say that by far the greater part of the coasts of these islands are fringed with it in many places to the breadth of half a mile: all the smaller islands are completely covered with it. It grows readily between clefts in the rocks, out of shingle and sand, close down to high-water mark; but it is most luxuriant where there is a depth of wet peaty bog. Whether it will grow upon boggy land further than half a mile from the sea, can only be determined by experiment. At the proper time I shall try it, and I entertain the most sanguine hopes that it will succeed, though perhaps it may not grow so luxuriantly as by the sea-shore.

If it should succeed upon inland bogs, such land could be made to yield as much nutriment for cattle as any other.

I am informed that a similar species of sedgy grass is to be found in the Straits of Magellan, the Auckland Islands, and many other places in the southern hemisphere; but, unlike its northern relations, the southern *Carex* appears everywhere to be tender, full of nutriment, and the favourite food with all cattle.

Extract from a later Report, dated October 1, 1842.

In my last Report I noticed the extraordinary dryness of the atmosphere, produced chiefly by the constant winds of summer. During the past winter months of June, July, and August, the excess of dampness and moisture has been equally remarkable, unaccompanied, however, by rain, and, comparatively with England, there was but little snow. The ice has been sufficiently thick to bear the weight of a man twice, for two or three days together; and the thermometer has occasionally been as low as 25°, and once 18° during the night. The wind has been by no means so strong or frequent as in summer; and calm days, with

sunshine, occurred very often—much more frequently than in England.

Upon the whole, the winter, though considered in this place as very severe, would have been thought a mild one in England. The dryness of the air is now again beginning to be apparent, and a fine summer is anticipated: already the thermometer has risen as high as 69°. My present opinion therefore is, that the winters in the Falklands may be considered very mild, but moist, though not rainy, and with little wind. The moisture does not arise from rain or fog, but from the nature of the ground (a light soil upon a tenacious subsoil), numerous springs and rivulets, and the absence of the evaporating winds of summer.

The plant described as the tussac by Mr. Hooker, in the enclosure which I had the honour of forwarding with my report, is of the genus *Carex*, and proves not to be the real tussac of the islands—which it very much resembles, and might easily deceive any person, the more so as it grows in the same situations, and is also eaten by the cattle. My friend Mr. Hooker has since given very great attention to this useful and interesting plant, which is a true grass, and in very much greater abundance than the other. As soon as I can collect some ripe seeds, I will also take the liberty of forwarding them; as perhaps your lordship may deem the grass worthy of a trial in England, both inland, as on chat-moss, and on the sea-coast.

Some seeds of the tussac grass, sown in the government garden, in good soil, different from that in which it grows naturally, and at a little distance from the sea, have shot up, and are likely to prove that this valuable fodder for cattle may be cultivated in any soil; but it evidently prefers moisture, and would probably require irrigation in a dry soil at any distance from the sea.

During several long rides into the country I always, as I have before stated, found the tussac flourishing most vigorously on spots most exposed to the sea, and in soil unfit for anything else to live in,—viz. the rankest peat-bog, black or red. It is singular to observe the beaten footpaths of the wild cattle and horses, as marked as a footpath across the fields in England, extending for miles over wild moorland, and always terminating in some point or peninsula covered with this favourite fodder; and amidst which it is almost certain to meet with solitary old bulls, or perhaps a herd, or a troop of wild horses just trotting off, as they scent it from a great distance.

To cultivate the tussac, I would recommend that the seed be sown in patches, just below the surface of the ground, and at distances of about 2 feet apart, and afterwards weeded out, as it grows very luxuriantly, and to the height of 6 or 7 feet. It should not be grazed, but reaped or cut in bundles. If cut, it

quickly shoots up; but is injured by grazing, particularly by pigs, who tear it up to get at the sweet nutty root. I do not know how it would be relished as hay; but cattle will eat the dry thatch off the roof of a house in winter. Their fondness for this food is so great that they will scent it at a great distance, and use every endeavour to get at it. Some bundles which were stacked in the yard at the back of the government-house were quickly found out, and the cattle from the village made repeated endeavours every night to get at them, giving much trouble to the sentry on duty to drive them away.

Extract from a Report of Mr. Hooker to Lieut.-Gov. Moody, inclosed in the foregoing Dispatch.

“H.M.S. Erebus, Berkeley Sound, Falkland Islands,
5th September, 1842.

“I shall now, according to promise, lay before your Excellency a slight account of some of the more useful plants of this colony, especially of such as appear to be at present, or may prove in time, of most use to man.

“The remarkable increase and fine condition of the cattle (comparatively speaking) recently introduced on the island naturally call the attention to the grasses in a country devoid of trees, or of any vegetable production likely to prove more important. Amongst these, which are very numerous, and form one-fifth of the plants hitherto discovered, the tussac holds the first place; as, however, you have a description of it, and know far more of its invaluable properties than I do, it would be useless to recapitulate here: suffice it to say, that with proper attention to its propagation in any locality near the coast, and preservation from being entirely eaten down where it already abounds, it alone would yield abundant pasturage for as many cattle as the island is ever likely to want.

“Another grass, however, far more abundant, and universally distributed over the whole country, scarcely yields in its nutritious qualities to the tussac; I mean the *Arundo alopecurus*, which covers every peat-bog with a dense and rich clothing of green in summer, and a pale yellow good hay in the winter season. This hay, though formed by nature without being mown and dried, keeps those cattle which have not access to the former grass in excellent condition—as the beef which our parties, for the four winter months, supplied the ships with, can abundantly testify. No bog, however rank, seems too bad for this plant to luxuriate in; and, as we remarked during our survey of Port William, although the soil on the quartz districts was very unprolific in many good grasses which flourish on the clay-slate, and generally speaking of the worst description, still the *Arundo* did not appear to feel the change; nor did the cattle fail to eat down large tracts of such pasturage.

“The numerous troops of horses, also, on the flanks of the Wickham Heights, can have little other fodder; whilst those of Mount Lowe and Mount Vernet must depend upon it entirely. Should the tussac disap-

pear from any part of the island where stall-fed cattle are kept, it might be advisable to treat this plant as hay is in Britain, by which means its nutritious properties would doubtless be much better secured to the animals during the winter months, than by allowing the leaves gradually to wither, and not gathering it until nature has dried them.

"For sheep, as hay, it would also do well; though I fear that it is of too wet a nature, and thrives best in situations far too damp for their succeeding on it all the year round. Experience only will prove this: at any rate newly-imported flocks should not at once be removed from dry fodder to any so succulent.

"You are aware that many English plants invariably follow man, undesignedly on his part; many such are common here—as the groundsel chickweed, and shepherd's purse, docks, &c.; and have been distributed chiefly through the agency of cattle, rabbits, fowls, and horses, more or less all over the island: amongst such, and most abundant of all, is the *Poa annua*, a very common English grass, and which forms a short bright green sward all the year round on the drier soil near the settlement, mixed with a few of the smaller native grasses and the common Dutch clover. Close to government-house there are many acres of such pasturage; the sheep seem very partial to it, and thrive uncommonly well: a little attention to its increase, especially by sowing it in similar situations, and draining the ground, might produce very beneficial results."

III.—On the Culture of Mangold-Wurzel.

By EARL LOVELACE.

I WRITE down a few particulars respecting the culture of the mangold-wurzel as I have been requested to do. The soil I occupy is a loam, working freely, but apt to burn in summer. The best practice I find is to plough up the land if a stubble in the autumn, first laying on about 7 or 8 loads of dung (of 50 cubic feet each). In the spring it is cross-cut and harrowed to a smooth surface. In April the ground is ridged at a width of 3 feet by a double mould-board going out and returning in the same furrow. The subsoil-plough follows immediately along the furrow, and stirs the ground 15 inches deeper; and the remainder of the 15 loads of dung allotted to each acre is put in the trench and covered in the usual manner. The mangold is sown on the newly-formed ridge with the Northumberland drill, about the end of April or the beginning of May; three or four weeks afterwards the furrows are subsoiled (so that the whole field is thoroughly stirred), and the plants are left to stand at intervals (in the lines) of 14 to 18 inches, the lines being 3 feet apart.

I will only add one word more about the second subsoiling. After the plants have come up, and are five or six weeks old, if you examine them you will find that even then their fibres are

nearly meeting: the subsoiling in the intervening furrow then heaves up the ridges on which they are growing, and they seem to float upon the soil; directly afterwards, I suppose, they dive down in quest of further nourishment. The plants grow so rapidly as to take entire possession of the soil, and the shade of the leaves prevents the growth of weeds; consequently no hoeing is requisite after they have been once thinned out to their proper distance. They are taken up in November, and have been kept till June or even July with care. The leaves are allowed to rot and dress the ground as a preparation for the wheat crop which follows. In France they are regularly pulled while the crop is growing for cattle; but probably the bulk of the root is lessened by this, as the absorbent surface of the leaf is important in supplying nourishment to the plant. The rotations are of the following cast:—

1. Wheat, followed by rye and tares.
2. Turnips.
3. Barley.
4. Clover.
5. Beans sown in February at 3 feet apart, followed in the same year by cabbages planted in the intervals in May or June.
6. Mangold-wurzel, and wheat again.

Or this.

- | | |
|--|---------------------------------------|
| 1. Wheat, followed by stubble turnips. | |
| 2. Barley. | |
| 3. Clover. | 3. Mangold wurzel. |
| 4. Beans and cabbages. | 4. Wheat. |
| 5. Mangold wurzel. | 5. Beans and cabbages. |
| 6. Wheat. | 6. Barley. |
| 7. Peas, followed by stubble turnips. | 7. Clover. |
| 8. Carrots, and wheat again. | 8. Rye and tares, afterwards turnips. |
| | 9. Carrots, and then wheat. |

It will be observed that the wheat follows the deep-rooted plants (wurzel and carrots) for which they are an excellent preparation; both the field and the quality of the wheat suggest the frequency of its variance in the rotations. Oats are excluded, the produce of barley being equal, and commanding a better price. Turnips and clover occur more rarely than in most rotations on light land, but the ground appears to require a longer interval than is admitted in the usual four-course system. Many dislike stubble-turnips; their produce is certainly inferior, but for a breeding flock such as is kept here they are eminently useful, and better for the ewes and lambs than a greater bulk of swedes.

Ockham Park, April 5th, 1843.

CROPS GROWN ON LORD LOVELACE'S FARM.

	Mangold-Wurzel (Long Red).			Yellow Wurzel (Globe).			Swede Turnips.			Carrots (Red).		
Date.	Tons.	Cwts.	Lbs.	Tons.	Cwts.	Lbs.	Tons.	Cwts.	Lbs.	Tons.	Cwts.	Lbs.
1831	58	8	60	..	..	..	42	2	0	..	..	..
1832	43	10	0	..	..	..	34	5	0	..	..	..
1833	47	4	0	..	..	..	38	4	10	..	..	..
1834	45	7	12	..	..	..	41	0	0	..	..	..
1835	46	1	0	..	..	..	37	0	0	..	..	..
1836	47	13	10	..	..	..	43	0	0	40	0	0
1837	50	1	0	..	..	..	36	0	0	35	0	0
1838	46	7	40	..	..	..	42	5	0	37	0	0
1839	51	2	0	..	..	..	37	6	0	42	0	0
1840	45	10	30	..	..	..	43	10	0	38	10	0
1841	44	15	12	42	3	0	38	8	0	37	6	0
1842	47	6	0	43	2	10	40	0	0	43	0	36

	Wheat.			Barley.			Beans.			
Date.	Bush.	Pks.	Gals.	Bush.	Pks.	Gals.	Bush.	Pks.	Gals.	
1831	37	0	0	48	0	0	..	..	..
1832	34	0	0	46	0	0	32	0	0	
1833	40	0	0	50	2	0	40	0	0	
1834	36	0	0	47	0	0	36	0	0	
1835	38	0	0	52	0	0	..	..	..
1836	42	0	0	44	2	0	42	1	0	
1837	39	2	0	36	1	0	37	0	0	
1838	38	2	0	50	0	0	39	2	0	and cabbage.
1839	40	2	0	48	0	0	41	0	0	ditto.
1840	37	2	0	50	0	0	44	0	0	ditto.
1841	38	3	0	56	0	0	41	0	0	ditto.
1842	40	2	0	32	0	0	40	2	0	ditto.

These weights of the root-crops have been ascertained by taking up three square perch of each in different parts of the crop, the swedes being topped and tailed, but the mangold tailed only. Although the spots have been fairly selected for weighing, it is possible that if a whole acre had been weighed the result might have been somewhat lower.

IV.—Evidence on the Antiquity, Cheapness, and Efficacy of Thorough-Draining, or Land-Ditching, as practised throughout the Counties of Suffolk, Hertford, Essex, and Norfolk, collected by PH. PUSEY. With Some Notice of Improved Machines for Tile-Making.

I. Suffolk Draining.—1. By the Rev. COPINGER HILL.

Now that Mr. Pusey has drawn public attention to the existence, for half a century, in the eastern counties, of a complete and economical system of drainage, it may not be amiss to describe in detail the practice to which he alludes.

On the heavy lands of Suffolk and the adjoining counties, under-draining at a distance of $16\frac{1}{2}$ feet, and a depth of 26 or 30 inches, is as much a matter of routine as hedging and ditching. It is done almost universally at the expense of the tenant, whether his tenure be at will or on lease. The outlay is thought to be repaid by the first crop; certainly by the second. My meaning is this: usually the land is drained the year it is fallowed; and when the period recurs for draining a field, I should expect, under favourable circumstances, that the increased value of the succeeding barley-crop over what it would have been without draining, would repay the cost of the draining.

Our system is especially intended to remove that wetness of the land which is caused by water becoming stagnant on the surface, from the retentive nature of the soil or surface materials; but it is also calculated to carry off the water which filtrates from higher grounds through beds of porous materials lying immediately upon impervious strata.

Much of our land has been repeatedly under-drained. The grandfather of the Messrs. Crosse, of Finborough, began under-draining ninety years ago.

Ours does not profess to be a permanent system, like tile or stone draining; but we think the second time the land is drained, in which case the old drains are cut across, that an additional benefit is derived.

On our strong clays, under-draining does not enable us to feed off turnips with sheep; it reduces the amount of horse-labour, inasmuch as the land is more easily worked, and sooner fit for work after rain; two horses *abreast* are universal in the plough, except that in wet seasons the three last furrows of our nine-foot stitches or beds are ploughed with two horses at *length*, in order to avoid treading on the ploughed land.

The drill and scarifier are each adapted to cover 9-foot stitches, once going and returning: the horses walking in the furrows: the shafts of the drill being set on one side, instead of the middle of the machine, and the scarifier being worked by means of a long whipple-tree. Our wheat is mostly dibbled, and we do not "consider the practice a strangely slow process:" hands are plentiful.

Even the best-drained land does not break up in such a friable state as to permit the drill to work immediately after the plough: hence the great inducement to dibble: land upon which wheat is drilled must be either summer-fallows, or bean-land ploughed directly after harvest, and left to the influence of the weather to be pulverised. All our lands intended for barley are ploughed for the last time in autumn, and scarified in spring before drilling. The surface of the land is left almost level by the scarifier, and is seeded throughout, furrow as well as stitch.

Seed-time and harvest are undoubtedly forwarded by drainage, but to what extent it is difficult to say, there being no means of comparison, as almost all the heavy lands hereabouts are drained more or less recently. Pasture is as much benefited as arable land. The grass is improved both in quantity and quality, and comes earlier in the spring.

We can carry more stock, owing to drainage, being thereby enabled to grow root-crops, particularly mangold-wurzel, and to feed off vetches in place of a portion of the clean fallow.

Old farmers describe a variety of practices (at present unknown) which existed before under-draining became general: such as laying the land for barley in 3-foot ridges, much as we do now for mangold-wurzel, and sowing broadcast; and drawing a log of wood along the furrow to let off the surface-water. They speak of the produce as increased from 16 or 18 bushels per acre of wheat to 24 and 28; while the increase in the barley-crop is quite as great.

The following extract from Dixon's 'Practical Agriculture,' vol. i. p. 373, new edition, published in 1807, may possibly be the means of further illustrating the advantages of under-draining; and it might be well to ascertain the present state of the farm in question, as well as the materials with which Mr. Salter filled up his drains:—

"At Michaelmas, 1795, Mr. Salter of Winburgh, East Devon, entered upon the occupation of more than 800 acres of heavy land, which had been so entirely neglected by his predecessor as to be almost altogether what it ought not to have been.

"Mr. Salter immediately saw that unless he could get rid of the surface-water all his labour must be fruitless, and his money expended in vain; he therefore began his operations by cutting 342 rods (7 yards to the rod) of river through the centre of the farm, 7 feet wide and 6 feet deep perpendicularly: in order to obtain an outlet for the water to flow from his other works, he cut 2937 rods of new and old ditches, 6 feet wide and 5 feet deep perpendicularly; 1116 rods of open drains, of various widths and depths from 4 to 5 feet wide and from 3½ to 4½ feet deep perpendicularly; and he cut *and filled up* 4871 rods of *under-draining*, of which the leading-drains were 36 inches and the feeding-drains to the same 30 inches deep perpendicularly. The whole of this work was executed and completed in one year. Mr. Salter has continued to do a great deal every year since 1795; between Michaelmas, 1800, and Michaelmas, 1801, he executed 4423 rods of under-draining, of widths and depths as before expressed; and he is now going on with the spirit and judgment of an experienced and an understanding agriculturist.

"*The effect has been*, that on the land which was so much impoverished by stagnant water, and so much inundated by land-springs, as not to reproduce the seed used upon it, his crops have been abundant: and while Mr. Salter reaps the benefit of his judicious exertions, he may very fairly be regarded as a public benefactor. He may almost be con-

sidered as producing a new creation around him, and should be held up by every friend to agricultural improvement to the admiration and imitation of all who have to do with *heavy land* from which it is necessary to remove the *surface-water*."

As to the districts which require draining, I do not know which to specify: all tenacious soils—I should think the neighbourhood of Hardwick, Tadlow, Gransden, in Cambridgeshire, and the bottom of the hills in Surrey and Sussex, and a large portion of Lancashire, Hertfordshire, Buckinghamshire, Kent, and Berkshire.*

In our own district, where the lands are under-drained, we detect the want of fresh draining instantly on walking across a field after wet weather: we detect it on our neighbours' land as well as our own, in passing through the country, by black spots on the surface, as the lands begin to dry in the spring.

Lands of a gently undulating nature are the most easily drained: our great difficulty is with flat land, where the watercourses are not for a sufficient distance under the control of the farmer, as is frequently the case in small occupations.

Our mode of cutting the drains is pretty uniform; the filling up varies: and here, as I am writing for the information of persons supposed to be altogether ignorant of the practice of draining, I would correct a misapprehension that prevails as to the term "filling up."

We do not, as in the case of stone and tile draining, "fill up" with any material through which the water drains; but our "filling up" is merely for the purpose of supporting the earth till an arch is formed; by which time the material with which we "fill up" is for the most part perished: a channel for the water is left clear beneath our "filling up."

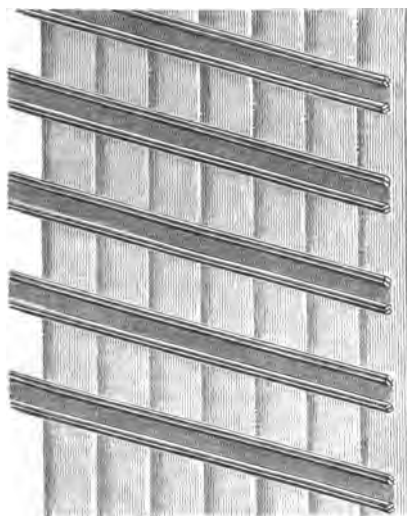
We fill up either with haulm (stubble), or ling (heath), or a scud of straw, or turf, or hop-binds twisted. Tiles and stone are disregarded by us, except for boggy soils, even since their use has been recalled to our notice by Scotch agriculturists; for our own system answers well, and is tested by time.

The tributary drains are drawn slantingly across the slope of the ground with a moderate fall. These tributaries at their lowest points are connected together by main drains, of the same dimensions as the tributaries, in such a manner that a group of tributaries and its corresponding main may take the water from half

* As a rule, under-draining should take the place of superficial draining, and high ridges and deep furrows be discontinued. One exception occurs to me, namely, peaty land—to which I think surface is more applicable than under draining: the peat seems to grow and fill up underground drains almost as soon as they are cut, and tiles are no defence against its encroachments; it finds its way through the points of junction of the tiles *readily*.

or three-quarters of an acre of land: the main drain opens into the ditch at a spot called the "eye." We do not interpose one large drain between the main drains and the ditch. I will detail as minutely as I can the successive steps in our progress, and I wish I was sufficiently master of my pencil to be able to represent them in that way, for I think I could then convey a clearer impression of our method than comes within the power of a written description.

1st. We draw the tributaries parallel to one another by means of a common plough going *two bouts* to each drain, thus opening a furrow 18 inches wide, and 5 inches deep:



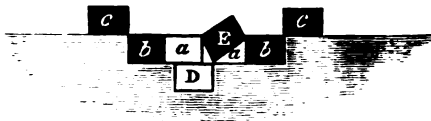
The following is a section of this stage of the drain:



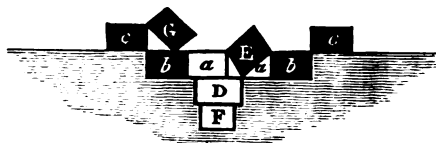
By the first bout *b* is turned up to *c* on each side; by the second bout *a* is turned up to *b* on each side. Thus leaving a furrow (*a a*) in depth 5 inches and 18 wide. Then we draw the main drains by the same plough, being guided in the direction of them by circumstances, such as shape of the field, fall of the water in the ditches, &c.

Then a large deep-breasted plough, kept for the purpose in some districts, going once down the furrow opened by the previous operations, turns out another furrow about 10 inches wide by 5

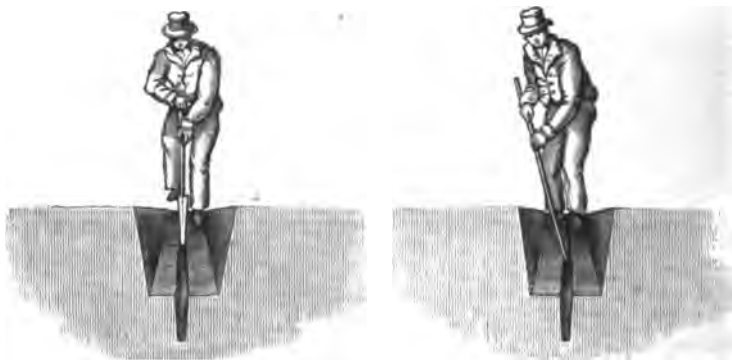
inches deep. Thus we have by means of the plough a drain 10 inches wide by 10 inches deep, as in the following figure, where E represents the slice turned out by the deep-breasted plough, and D the furrow formed by it.



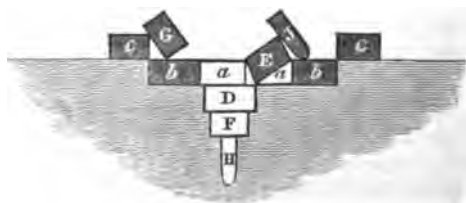
A labourer with a common spade now digs out a spit 9 inches deep, beginning at the eye, according to the following sectional view, where G represents the spit thrown out by the broad spade, and F the trench made.



Then with a narrow spade the labourer takes out 11 inches more, and scoops out the crumbs :



In the following sectional view J represents the spit thrown out by the narrow spade, and H the trench or drain left by it :



In digging with the broad spade regard is had to the inequalities of the surface ; a greater or less depth is given according as the ground rises or falls : the depth of the narrow drain is uniform throughout.

Scoop.



Narrow Spade.



If he meets with stone or gravel, he picks or digs them out, and rams down stiff clay into the holes so made, through which he cuts his drain afresh with his narrow spade.

The drains are now 30 inches deep ; the narrow spade is $1\frac{1}{2}$ inches wide at bottom, and $2\frac{1}{2}$ inches wide at top ; it is in depth 13 inches, but being necessarily worked in a slanting direction, only digs out 11 inches. A few years since the practice was to dig 15 inches with the narrow spade immediately after the plough : this has given way to the method above stated.

A small quantity of stubble is now laid along the narrow drain, the labourer walking in the drain presses the stubble about 3 inches down into the narrow drain with his spade. The stubble is not pressed to the bottom, but a free passage for the water is left under it. Earth, heavy or light indifferently, is then shovelled in over the haulm, and the common plough reverses its former work, as in the following figure :



Sometimes heath is used instead of stubble ; sometimes hop-binds twisted ; sometimes a scud of straw, made to fit the upper part of the narrow drain. Occasionally a waggon-rope is laid along the bottom of the drain before the filling up is done, and the rope is afterwards drawn along, thus securing the drain from crumbs of earth at the bottom ; but this precaution is unnecessary. At other times all filling up is dispensed with, and a board of the same dimensions as the narrow drain is fitted into it ; the earth is then rammed down on to the edge of the board, and the board is drawn along the drain, leaving an arched waterway behind it. A

considerable farm in my neighbourhood, belonging to Sir Henry Leslie, of Cockerell's Hall, heretofore neglected, is now undergoing this operation, mainly, I believe, in consequence of the shortness of the straw-crop of 1842. The tenant informs me that some drains cut upon the farm six years ago, according to this principle, are now running well.

Sometimes faggot-wood is laid along the bottom of the drain with haulm over it, the water finding its way through the wood; a great portion of Clopton Hall Farm was drained in this way some thirty years ago: this mode is expensive, and is adopted by new men only, who feel misgivings (which are not warranted by experience) as to the stability of stubble-draining.

But, better than all, peat cut for the purpose in the fens of Cambridgeshire, in length 15 inches, and 3 inches square, is pressed gently into the top of the narrow drain, and the earth thrown in upon it; the peat swells speedily, and becomes firmly fixed, and is very durable, and has this advantage over the methods already specified, and also over tile-draining, that a fold-stake driven into it commits no damage. In peat-draining, when we come to stony or gravelly spots, two pieces of peat, instead of one, or one and a half, are placed in side by side; or, in bad cases, the sides of the drain are built with turf, as well as the top. Stubble, heath, hop-binds, straw, are quickly decomposed and washed away; peat remains. Sir H. Davy says, "Inert peaty matter remains for years exposed to water and air without undergoing change." *

In draining pasture-land we only go one bout with the common plough; then one spit with the broad spade, and one with the narrow: sometimes the narrow spade is used immediately after the plough; and we do not drain pasture so closely as arable land.

As for expense: in 1841, when day wages (not the average weekly earnings throughout the year, which are one-third more than the daily wages usually quoted) were 10s. per week and beer, the broad and narrow spade-work and filling in was done for 4s. per score rods, of 16½ feet to the rod; or 32s. per acre if the drains are a rod apart, and 6d. extra for each eye, and good earnings made: half a score poles in winter is about a day's work. If the ground is stony, the work is longer in hand; but the drainer is paid per bushel for the stones thrown out, which are carted into the roads.

The expense of filling up depends on the material used;

* The writer caused one of his peat-drains to be cut transversely by a sharp spade, and found the peat firmly fixed; a portion of it had insinuated itself between the shoulder of the narrow drain and the loose earth thrown upon it, presenting the appearance of the head of a nail.

stubble costs nothing, but robs the muck-hill. When heath or peat are within a day's cartage they are used. I used to cart heath a distance of 20 miles, occupying two entire days therein; I now cart peat a distance of 33 miles, my waggon being out three entire days.*

As for durability, I cannot do better than quote the words of my friend Mr. Moore of Badley:—

“In my occupation of upwards of 500 acres I have not more than 40 upon which drains are not required; all the remainder, viz. nearly 500 acres, have been once drained by me, and a considerable portion of it twice. I have not more than 5 acres whereon I have used tiles; some of which I have also twice tile-drained, in consequence of a deposit accumulated of a sandy nature. The soil in my occupation is very variable, for even in the same field I have a subsoil of light loamy sand, very strong clay, and a gravelly red loam, so full of stones that some parts of the drains are obliged to be made by a pickaxe and other iron tools previously to using the narrow draining-spade. I have this year (1843) drained where 95 bushels of large stones per acre have been dug out of the drains and collected. At the time I am writing this I am draining a field of 8 acres, and I find it is twenty years since I drained it before. This field contains all the various soils before mentioned; and my men are using in many parts pickaxes, &c., to get through the stone. Although I have exceeded my usual time in renewing draining in this field, I have not observed one of the old drains actually blown or choked; but, as a matter of course, they are in many places very nearly worn out; yet in other parts of the field, where the soil is a strong loam, the drains are in very good condition. I am by experience convinced that where under-draining is performed, as in the usual manner practised in this neighbourhood, *i. e.* the drains first drawn by a plough 8 or 10 inches deep, dug 10 inches with the broad spade and 10 inches with the narrow, filling the top of the narrow drain with stubble; the drains will last from twelve to twenty years.”

Mr. Moore uses no other material than what is provincially called haulm (stubble) for filling up.

I can mention a curious illustration of the past practice of under-draining in England:—My friend, Mr. Anderson, had occasion to drain a field, and in doing so cut across the “old drains,” out of which he took several bushels of “bullocks’ horns:” upon inquiry he found that the field formerly belonged to a “tanner;” but no one in the parish remembers the “tanner.” And upon my repeating the circumstance very lately, I heard of another instance of filling up with bullocks’ horns.

I have described as well as I am able, and with a minuteness which will appear trifling to many, the practice of draining which

* Peat sells at the rate of 6s. per thousand; eight score of draining to the acre requires two thousand peat.

exists among us. I cannot close this paper without one word on tile and stone draining.

We have attended to all that has been said on the subject during the last few years, but I do not think any addition has been made to our knowledge; at all events, no general change in our practice is contemplated. We were certainly under the impression that our mode of draining was well known to agriculturists; and were much surprised by the announcement made in Mr. Pusey's summary of the progress of agriculture in the last four years, that it had only recently and by accident come to his knowledge. Our drains afford a waterway of 15 square inches in section: to obtain a similar one with tile would involve an expense utterly beyond our means. Besides, they would be as liable to stoppage as our own. Such is Mr. Moore's experience, and such is my own on a small scale; tiles laid down in boggy soil on my own farm many years ago have ceased to act, and when examined are found to be full, and for the most part broken.

As for stone-draining, I am at a loss to guess where the material is to be got on heavy soils; certain it is that the road-surveyor in our neighbourhood is glad to pay 4s. for 25 bushels of picked stone carried into the roads. And I suspect stone drains would quickly choke. I made one small drain six years ago in this manner in compliment to the new system, and it failed in a year or two.

I do not suppose that my description of our mode of draining is clear enough to enable farmers to adopt it without inspecting the practice; and I think there is some danger of the system getting into disrepute if it is attempted. Surely it would be worth the while of young farmers from the undrained districts to learn the practice by a short sojourn on the farms of some of our best drainers, and thus copy the professional man, who obtains an accurate acquaintance with his particular science by studying each department of it in its own especial school.

Buxhall, Stowmarket.

I. *Suffolk Draining.*—2. By SAMUEL JONAS.

To Ph. Pusey, Esq.

DEAR SIR,—I went over to my father's yesterday to obtain information respecting thorough draining, and I here forward you the information obtained. Mr. S. Jonas, of Great Thurlow, Suffolk, states that he is aged seventy years, and that his father died fifty years ago, and was aged eighty years; that he has heard his father talk of hollow draining, and that he had the tools his father's men used for that purpose, so that you may fairly conclude that hollow draining has been done in my own

family a hundred years back. And as I believe in no county is this kind of work done better than in Suffolk, I send you the manner in which my father has had this work done for the last half century. He draws his ditches within 4 yards of each other, digs the ditch out two spit or 18 to 20 inches deep with the wide spade, and 10 inches with the narrow spit, making the total depth of ditch 28 to 30 inches. The soil is a close tenacious clay; he has bridges with joints, which are pieces of wood made the size of the lower drain, viz., about 8 inches deep, $3\frac{1}{2}$ inches wide at top, tapering to about 2 inches at bottom; these are drawn along in the ditch by a lever, and the soil taken out with the narrow spade is then laid on the bridges, and then rammed down light and close over the bridge, which is then drawn forward and more soil rammed, leaving a hollow space, with a tough, compact arch of clay. Some people have objected to this plug or ramming system, stating that the water will not penetrate the earth thus rammed; but to prove how durable this plan is, as well as effectual, in the draining of the land, my father is now hollow-draining a field that was hollow-drained the same depth, viz. 30 inches, twenty years ago, and rammed, and during the twenty years has never had occasion to draw a water-furrow on the land, as it was absorbed by the soil, and ran off in the hollow drains. He never has during that time known any water to run or stand in the furrows. I think this is strong evidence of *thorough draining* having long existed in Suffolk.

At Radwinter, in Essex, on a farm belonging to my wife's mother, after having dug the earth out to form the ditch, we lay a plug of peat, which is obtained from the fens in Cambridgeshire. These pieces of peat are cut to a proper size and length, and laid in the lower or narrow part of the drain, this part of the ditch being narrower below than at top. The sod of peat rests on the two sides of the ditch, leaving a hollow space below of about 3 inches, and we find this a very good plan; but if the soil is a loose sort, so that the sides of the ditch will not stand sound, we are obliged to fill up with straw and bushes.

Yours faithfully,

SAMUEL JONAS.

Ickleton, Saffron Walden,
April 7, 1843.

II. Hertfordshire Draining. By W. FLACK.

To Ph. Pusey, Esq.

SIR,—In the last number of the 'Agricultural Journal' you mention having requested Mr. Ransome to make some inquiry as to the length of time the practice of thorough or frequent draining could be traced back in the county of Suffolk; and as I happen to have it in my power to show it has been practised much longer in this neighbourhood than is there stated, I take the liberty of sending you the following statement.

I have in my possession an old day-book of Mr. Robert Climenson's (Mrs. Flack's great-grandfather), who occupied what was then the most considerable farm in this parish, in which there

are various entries of payments for many hundred poles of "under-draining," beginning in 1743, and several following years, sufficient to show it was practised to a considerable extent at that time; and I have every reason to believe it has been used ever since, as my own knowledge extends to about forty years, and when a boy I have heard old labourers speak of what was considered a good day's work when they were young men.

Having thus shown that the system has been in operation in this the eastern part of the county of Hertford for a century, I will now state some of the particulars; but perhaps I ought to state previously, that, unlike most of the strong land in many of the midland and other counties, in Herts the land lies nearly flat, and therefore it is usual to cut the drains directly across the shot (as we term the course of the plough), at least as much so as can be, to get a sufficient fall for the water. I would also observe our object is to get off the *surface-water*, as we are seldom troubled with springs on these soils.

1. *Depth and Width*.—A bout is first drawn with the plough deeply, casting a furrow each way; then dug 22 inches the parallel drains, and from 26 to 30 inches the leading drain; the wedge shape—10 inches at the top to 2 inches at the bottom.

2. *Distance*.—16½ feet from drain to drain.

3. *Materials*.—Thorns are preferred, but when sufficient are not to be had, we use the underwood cut from the woods: they should be laid as regularly as possible—one part lapping on to the next layer, in the way the straw is laid by the thatcher—enough to rise about 4 inches from the bottom of the drain when well pressed down, which is considered important; then a thin layer of straw or haulm, sufficient to prevent the soil from getting to the thorns. The top spit, which is laid as near as possible when dug, is then put in with some of the surface soil, as being the more porous. The bottom spit, when dug, is cast some on each side, and beyond the other, so that it may be spread over the surface of the land.

4. *Expense*.—The digging and filling in cost about 4s. per score poles of 16½ feet (8s. per furlong), varying a little more or less according as the land works. There is a greater variation in the expense of the materials, but the average cost is about the same as the labour, which would be—

160 poles, digging and filling	. . .	£1 12 0
Ditto, materials	. . .	1 12 0
		<hr/>
Making, per acre	. . .	£3 4 0

5. *Durability*.—On the strongest clays, when well done, they will last twenty years, and sometimes more. In some lands even the strongest clays are intersected with veins and small patches of

a tender crumbling substance, called by the labourers *hurrick* which will not stand longer than the thorns last, and which soon spoils the drains—perhaps in ten or twelve years. In such cases it is usual to cut a few fresh drains across the old ones, which bleed them, and lay the land dry for some years longer.

6. *Efficiency*.—They are so efficient as completely to effect the object desired; and are considered, in most cases, to return the outlay in the first two or three crops. I should say the benefit is greatest on those soils that have a tolerably good depth of staple or useful soil. On the thin clays, though quite as necessary, the immediate improvement is not so apparent. Without draining, however, these could not be cultivated to any advantage; and here are never attempted to be so cultivated, if the occupier has the means to drain.

By means of improved machinery drain-tiles are now much reduced in price; but, after much attention to the subject, I prefer the thorn-drains, as much of our clay is of so tenacious a texture that I think it would soon become so consolidated over the tiles as to prevent the water reaching them, unless they were filled over the tiles with broken stones, or some porous material, which would very greatly increase the expense.

I remain, Sir,

Your obedient servant,

W. FLACK.

Waters Place, Ware, January 11, 1843.

III. *Essex Draining*—1. By ROBERT BAKER.

[*This and the two following statements were obtained for the Society by Mr. Bramston.*]

UNDER-DRAINING has been long practised in Essex: the commencement of the system I have no opportunity of ascertaining; but from observations that I have heard made by others, I believe it was prevalent through all that portion of the county where the white chalk clay abounds—taking in nearly all that portion lying north of the line extending from Great Tey to Chelmsford, and from the latter place to High Ongar and Epping.

The roothings and parishes around Dunmow have been most remarkable for its being carried out extensively; it has at a later period been introduced upon the mixed and gravelly subsoils, consisting of chalk, loam, and clay, mixed in different proportions.

The chalk-clay is a deposit resting upon the London clay, and varies in thickness from 10 to 100 feet. As it approaches Cambridgeshire it becomes mixed with a larger proportion of chalk, and at Saffron Walden is superseded by the chalk which extends northward through that county. This soil is peculiarly adapted to draining, and produces excellent wheat and barley crops in alternate years under the system. The

subsoil admits water readily, which passes off quickly into the drains, which are also very durable. As to the antiquity of the system, as carried out in this county, the earliest writer that I have met with who mentions it is the author of a work entitled 'A Six Weeks' Tour through the Southern Counties in 1767,' and published in 1769. This tour is stated to commence at Wells, thence to Hadleigh in Suffolk, Norfolk, Essex, Kent, &c.

Throughout the tour, extending over all the southern counties lying south of the line from Cambridge to Bristol (accurately described as to farming minutiae), the author makes no allusion to draining until he comes into Essex. He states, "a remarkable particular I observed in their husbandry was the care with which they drain their wet lands (especially in this district, Braintree). They make hollow drains, the main ones 2 feet deep, and the branches 22 inches; they lay some small wood at the bottom, and a good deal of straw upon it, and then cover the whole with earth. The price of this work is 2*d.* per rod and their small-beer. It were much to be wished the practice were more general, for it is an admirable one, and well deserves imitation," &c. At page 255:—"One circumstance I should not forget, and that is their hollow drains, of which they do a great deal in their wet lands; and this excellent practice I found scarce anywhere but in Essex and Suffolk.

In Vancouver's 'Survey of Essex,' published in 1795, draining is mentioned as peculiar to Essex. "The drains," he says, "are laid off at 2½ and 3 yards apart, 26 inches deep, and filled with wood and straw, at an expense of from 50*s.* to 60*s.* per acre."

Draining has been considered indispensable to the well-cultivation of the chalk-clay lands of this nature, and is carried on extensively at the present moment.

Other modes are, however, adopted both by the 20-horse power and windlass mole-plough—the latter in many districts has superseded the use of the spade. The cost of this method at 4 to 5 yards apart, with the leaders dug and filled with wood and straw, does not exceed 20*s.* per acre; 15*s.* is the medium price, including the horse-labour; the common plough is first used to the depth of from 4 to 6 inches, and the mole-plough passes at a further depth of from 12 to 16 inches. These drains draw quickly, and are durable on the best chalky-clay soils, and will if well done continue to work well from ten to fifteen years, but upon loam or gravelly subsoils the process will not succeed.

Drains in the former mode by the spade are first opened by 4 furrows ploughed out by a common foot-plough, transversely of the stitches, at from 5 to 6 yards apart; the drains are cut by two operations of the spade—the upper spade being about 3 inches wide at the point, and 10 inches long, the lower spade about 2 inches wide at the point, and 12 inches long; the drain is cleared with a long scoop; wood is carefully placed at the bottom, about 2½ inches high, and covered with straw about 2 inches more. In some cases straw or haulm is only used, in others the earth is rammed in upon a piece of wood made to fit the bottom of the ditch, which is drawn forward as the work proceeds, leaving a hollow drain. The cost of digging is from 3*s.* to 4*s.* per score

rods, and in some cases 5s.; 8 score rods to the acre averages about 30s.; labour, the ploughing, and for wood and straw about as much more, making altogether from 2*l.* 10s. to 3*l.* per acre: if wood and straw are not used, 1*l.* per acre may be deducted.

This system is *practised* upon about two-thirds of the whole county, of which one-half is well drained. The drains upon the best soils will last from ten to fifteen years. The average time is considered to be about ten years. By actual calculations entered into with others on various occasions, the expense of maintaining a good system of draining amounts to 5s. per acre per annum by the spade, and about 2s. 6*d.* per acre by the mole-plough.

The tenacious lands, consisting of the London clay as the subsoil, are very retentive of moisture, and most of them will answer well for draining: the same mode as described above is resorted to; but the drains are not more than two-thirds as durable. Tile and pipes have of late been introduced, but do not answer well unless covered about 2 inches with shingle-gravel or cockle-shells, which are found in abundance on the coast. Drains of this character are very durable; but the cost is too great for tenants, unless under long leases, to introduce into practice. The cost varies from 5*l.* to 8*l.* per acre, according to the distance of cartage, and must be equivalent to as many shillings per acre on the annual rental value. The pipes of 1½ inch bore are 1 foot in length, and cost from 25s. to 30s. per thousand; tiles and bottoms cost from 40s. to 50s. per thousand. One-fourth of these lands only, it is presumed, are at present drained.

The gravelly and mixed subsoils are now pretty generally drained (where the farms are under good management), and probably answer as well as upon any other description of soils. Until within five or six years scarcely any pipes or tiles were used; but they are now more in use, but not generally so. The drains on *these* soils by the spade, as before described, and filled with wood and straw, soon become useless, but with pipes or tiles are far more durable; the cost is the same as before enumerated—but the original system is nearly as expensive as by pipe when the short duration of the drains upon *this kind of land* is taken into consideration; but the pipes are too expensive for tenants generally to adopt. About one-half of this description of soil only requires draining, and not one-half of that is drained.

The depth of 22 inches is almost universally adopted, except in a few instances, but 30 inches has been lately practised.

The drainage of bogs and morasses is not well understood in this county; there are still many hundreds of acres that might be doubled in value by a judicious application of the system, and at a less cost per acre even than by the before-described method.

If draining is well effected upon the chalky clay soils, the drains should not draw off the water too quickly, as a great portion of manure would be thereby lost. No system can be better to effect the object than the wood and straw drains cut with the spade at 5 yards apart and 22 inches in depth upon soils suitable; and the white chalky-clays are especially adapted for this process, and upon such soils I think this system nearly equal to tiles, as the latter do not draw freely

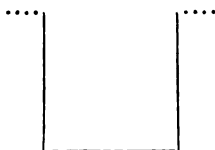
unless gravel or some porous material is placed over them, which it is difficult to obtain in these districts; and the expense to maintain a good system is also less than by tiles, taking durability and expense into consideration.

Writtle, Chelmsford, March, 1843.

III. *Essex Draining*—2. By MARTIN NOCKOLDS.

QUESTION 1st.—Antiquity of Draining.

From inquiry I have made amongst the oldest farmers in this neighbourhood, I find that draining was practised 150 years ago; the system then adopted was to dig out a trench the width of a broad spade thus,



and fill in with a large quantity of bushes. My informant could not state how long this practice continued, but he recollects that the narrow spade was used for draining as long back as the year 1780, and probably before that time.

Question 2nd.—Extent of district drained.

I am of opinion that nearly all the clay soils in this district have been underdrained at different times either by mole-plough or spade, but the drains have not been renewed so often as necessary; and ten years ago, after a succession of wet and bad seasons, attended with low prices of agricultural produce, nearly all the clay lands were in a very bad state of cultivation from want of draining. Since that time there has been a gradual improvement, but I think I am warranted in stating that as yet one-third only has been effectually drained.

Question 3rd.—Material used.

Thorn and straw universally until within the last fifteen or twenty years. The system of ramming is now introduced on sound clay, and appears to be getting into general use; the great advantage is economy, and I am informed that it draws off the water effectually if thoroughly done, but requires the master's attention more than any other mode, and is not so durable. Peat, brought from the fens in Cambridgeshire, has also been used during the last ten or fifteen years, and is considered more durable than any other material except tiles; but it is rarely used in this neighbourhood, except for leading drains and outlets. The general opinion is, that the tile will not answer the purpose on clay soils unless bushes, stones, or peat be laid over them.

Question 4th.—Interval and depth.

Usually 5 yards asunder, depth from 20 to 30 inches. Our practical men are quite at issue as to the depth of drain most suitable on the clay soils, but deep draining is, I think, getting more into practice every day.

Question 5th.—Price per rod.

Manual labour from 3*s.* to 5*s.* for 20 rods, according to depth of drain and nature of soil. The total expense is upon an average about 50*s.* per acre, but if rammed or dug about 20 or 22 inches deep does not exceed 40*s.*; and if peat is used, and the drain made 30 inches deep, the expense would be rather over 3*l.* per acre.

Question 6th.—Is the first spit raised by the plough?

Yes.

Question 7th.—Duration of drains.

From eight to sixteen years, according to the depth of drains and mode of filling.

Question 8th.—Variation in stiffness of land drained, and consequent adaptation of mode of drainage.

There is a great difference in the stiffness of land drained, but notwithstanding which the usual practice is to set out the drains about 5 yards asunder. The mode of drainage varies according to the opinion of the occupier.

Question 9th.—Whether thorn or tile draw off the water best on stiff clay.

Thorn. Tiles are in limited use in this neighbourhood, but it has been proved beyond doubt that, unless bushes, stones, or peat be put over them, the water will not draw off well on the stiff clays. It is the opinion of most of the practical men in this neighbourhood that peat-draining is the most effectual system adopted; the drains to be 5 yards asunder, and from 26 to 30 inches deep. This mode is considered to be the most durable, except tiles covered with bushes, stones, or peat.

Saffron Walden, March, 1842.

III. *Essex Draining*—3. By J. OXLEY PARKER.

To W. Bramston, Esq., M.P.

MY DEAR SIR,—With respect to “the antiquity of land-draining,” or *land-ditching*, as it is more generally termed in this county, I am unable to arrive at any very definite conclusion; but from all that I can gather on the subject, I should be inclined to believe that the system has prevailed, as a necessary adjunct to good farming, and as far as the cutting of parallel drains, filled with wood and straw is concerned, for a good

century past.* The removal of superfluous water from the land by surface drainage, or by land-ditching, appears to have been time out of mind an acknowledged principle of good farming, without which all applications of manure, or other acts of husbandry, would be rendered comparatively valueless and ineffectual. Indeed, it seems to have been long regarded as the *sine quâ non* of good farming: and in conversing with several old labourers, with the view of learning the practice of former times, I have found that they were accustomed to the work from their boyhood, and that their fathers had been in the habit of engaging in the same kind of labour before them. I am not led to suppose from this that the system was so generally adopted as at the present day, or that anything like the improved method of drainage by pipes, tiles, &c., were adopted; but the draining of wet or springy lands by ditches filled with wood and straw or stubble has been much practised in this county for a long period, and, at the same time that it has increased the productiveness of the soil, has tended to improve materially the healthiness of the climate.

The districts in Essex in which land-ditching is most general are the large extent of the clay soils of the Roothings, on the west and north-west of the county, and those portions dispersed in irregular sections, and of various extent, in other parts of the county, which are composed of gravel, loam, and clay, in different degrees of admixture.

In the districts which lie upon the substratum of porous and chalky clay, or marl, the system of shallow parallel drains filled with wood and straw, or straw only, twisted or "*scudded*," is universally adopted; and, from the porous character of the soil, the water being enabled to find its way into the drain on all sides by minute and general percolation, the drains are not subject to be washed in or choked, and remain open and clear for many years. On such land, where the subsoil is sufficiently firm and cohesive, the mole-plough is used with great advantage. The drains so formed will sometimes run well for ten, fifteen, or twenty years, and when worn out, if the lines originally formed by the mole-plough be intersected by drains, cut with the spade, at the depth of two or three inches below them, the land is again most effectually relieved of superfluous moisture.

In those soils composed of irregular beds of gravel and loam, where the gravel cropping out upon the loam causes the land-springs to rise and *spew* out upon the surface, drainage by tiles, as well as wood and straw, is very generally adopted; and this would be practised to a much greater extent were tiles to be obtained at a lower cost. The introduction of tiles at such a price as they can be made by Mr. Beart's, and other machines of recent invention, would, in all probability, give a new im-

* "Mr. Bramston's deer-park at Skreens," observes Arthur Young in his 'View of the Agriculture of Essex,' vol. ii. p. 189, printed in 1807, "was made in 1664, and he has reason to know that it was never drained after being made a deer-park, till he did it; in which work the men found evident traces of very ancient drains, and pointed them out to him. Hence it is clear that this practice was known in Essex long before the period to which it is sometimes assigned." Mr. F. G. Bramston, the present owner of Skreens, to whom I showed the above passage, has no means of ascertaining whether his grandfather's data were correct.—BRAYBROOKE.

petus to the system of tile-drainage, and many districts might, by this means, be rendered vastly more productive than at present. The ordinary farmer, unless assisted by his landlord, is unwilling to embark in an outlay of 5*l.*, 6*l.*, or 7*l.* per acre, though both landlord and tenant might be induced to co-operate and join in the expense, when it is only clearly placed before their eyes that the same benefits can be made available at half the cost.

Where the soil is full of land-springs, and it is necessary to dig the ditches of greater depth, stones are frequently used over the tiles to fill in the drains; and where they can be readily obtained, nothing is better suited to fill the parallel drains than stones alone, a small portion of straw being spread over them before the earth is thrown in, and tiles being placed at the bottom of the leads to carry off the greater quantity of water accumulated in the side drains. For this purpose the stones *cannot be too small*. The finest gravel, *well sifted*, or sea shingle, are both excellent materials, but better than all is the broken cockle-shell occasionally to be procured on the sea shore. If, in the first instance, a laying of straw be placed on the top of such material, to prevent the first sediment from the upper soil settling down and choking the small cavities and interstices of the stones or shingle, the superincumbent earth will soon form an artificial stratum or crust over the top of the drains, so that the loose surface soil will not be liable to fall in and mix with the stones, and the drains will be found, after many years, as free from soil or obstruction as when first laid down, and would appear to give good promise of lasting for ever. Though it is contrary to the opinion of some persons, in draining flat land there is no kind of material which I would prefer to stone or shell, as I consider that tiles would in such case be much more liable to choke, requiring a certain declivity and readiness of fall to keep them clear.

Upon the stiff loamy clays of the hundreds of Essex, in the eastern and south-eastern parts of the county, land-ditching, by covered drains, has been only partially adopted; and many of the best practical farmers, and men, too, not blinded by prejudice to a fair consideration of the subject, doubt whether the system can be generally practised with advantage on such soils.

Where the soil is uniformly composed of that stiff and impervious texture which does not admit of the water which falls upon it soaking below the top-surface moved by the plough, it is thought better to lay up the land in ridges or stitches, from which the water is taken by the intervening furrows, and by them, at certain intervals, into cross furrows drawn by the plough at a greater depth, and afterwards dug or "*spitted*" by the spade, so as to carry off the water rapidly and freely by surface drainage. If drained at all, the ditches in such land are seldom cut deeper than 14 or 15 inches below the plough, and they are necessarily placed at frequent intervals, commonly 1 rod or 16½ feet apart, from the circumstance of the impervious subsoil only allowing the water to find its way into the drains by perpendicular fall, instead of the oblique and gradual percolation by which it is carried off in more porous strata. The only way to obtain a free passage to the drain below, is by filling in the cavities formed by the spade with the loose top-soil of the surface.

This, as soon as the wood or straw begins to decay, the perpendicular pressure of the water will cause to fall in; whereas, should the stiff soil taken out by the spade be replaced, with the view of rendering the drains more secure, it will soon become so closely wedged into the narrow space from whence it was previously taken, that though the drain remains open at the bottom the water will be unable to find its way down to it.

Added to this, such drains are liable to be choked by the thin silt driven by the autumn rains into the fissures caused by the drought of summer; and water is thus admitted into a sub-soil from which, by good surface-drainage, it could be almost entirely excluded.

This latter remark would, I conceive, apply equally to the use of tiles in such land, as the silt driven into the fissures would effectually obstruct the drains, and throw the water out upon the surface.

The only materials capable of being used with real advantage on such soils are, I should imagine, those to which I have previously referred, viz., small stones, shingle, or shell; but these can usually only be imported from a distance, and at considerable expense, so that the consequent cost renders it almost hopeless that such a mode could ever be generally adopted.

I have entered more at length than perhaps is necessary into this subject; but the conviction, that such land would be much improved if it were possible to drain it effectually—that it would be less subject to the destructive injuries of wet seasons—that it would be more easily worked at all times—that the ploughings of autumn and wheat-seed time would be less hazardous and laborious—that the tillage of spring would be more certain and earlier—makes me feel deeply interested in the subject, and anxious to see such a system introduced as would bring about the desired result. Never having been in Scotland, I cannot speak from my own observation, but from all that I have read of the draining of the heavy lands of that country, I have never been able to conceive that the heavy lands to which effectual drainage has there been applied are equal in stiffness, in tenacity, in stubbornness, to our own; and I have always judged from such incidental observations, as “the possibility of ploughing at all times with two horses,” &c., that I am in some degree justified in my conclusion. Besides this, I was struck a short time since by an observation of Mr. Hyde Greg, in his recent pamphlet on the subject, who, after extolling the practice as *applicable to all land*, cannot at last avoid the admission, that the land to which he has referred can hardly be so heavy as some of the heavy land of England.

Wherever land is not uniformly sound, but intersected by veins of looser soil, there drainage must of necessity be applied to let out the water which such veins have admitted; and on the tenacious loamy clays where this is the case (until some better method is introduced), drainage by shallow ditches, filled with wood and straw, and frequently renewed, is, perhaps, the best method that can be adopted.

In clay soils the drains are seldom more than a rod or a rod and a half apart; in gravelly soils, where the water will draw more readily through the subsoil, they may be further distant, but of greater depth, so as not only to carry off the water rising from the springs below, but also to give that from the surface a readier inclination to the drains.

As regards the expense, in clay soils which dig well, the cost for labour (exclusive of materials) will be, where the drains are 14 or 15 inches deep, 2s. 6d. per score rod; when the drains are from 18 to 30 inches, from 4s. to 6s., according to the nature of the sub-soil. In hard and gravelly land, where the drains cannot be dug freely with the spade, the price must vary according to the labour. The top-soil is not often removed by the spade; the plough is generally used, and two furrows raised by it before the spade-work is commenced.

Believe me, my very dear Sir,

Yours very faithfully,

Woodham Mortimer Place,
March 11, 1843.

J. OXLEY PARKER.

IV. Norfolk Draining. By HENRY EVANS.

I HAVE taken the earliest opportunity to make inquiries as to the under-draining of this county; and I have preferred Mr. Mach as an authority, as I do not believe there is a man in Norfolk who better understands the subject. The greater part of his farm is wet and requires under-draining; and, consequently, he is a *practical* man. I shall take the four questions you have proposed to me in their order:—

Question 1st.—How long the practice has lasted.

An old labourer, above eighty years of age, on this farm, says that his father was the first who bought tools for under-draining in this district. He thinks the practice has prevailed for a century and half.

Question 2nd.—Over what extent of country.

Throughout the whole county of Norfolk.

Question 3rd.—At what price per pole.

4d. per pole; but the providing materials and casting will add 2d. per pole.

Question 4th.—At what distance and depth.

32 inches is the depth on strong sound soil; but on soft spongy soil the depth must depend on circumstances. You will get the drains as deep as you can, generally 28 inches, but very frequently you cannot get this depth, as the soil boils up as fast as you remove it. The distance will vary from 5 to 8 yards, but 7 yards is considered the average distance. The cost of under-draining land will average about 40s. per acre.

I have thus endeavoured to answer the proposed questions, which are difficult, inasmuch as everything depends on the nature of the soil, the fall of the water, and various other local circumstances; but the information is correct as far as it goes.

Lyng, March 14, 1843.

Remarks on the foregoing Evidence. By PH. PUSEY.

This body of evidence, for which I beg to thank those members who have furnished it, sets at rest any question as to the English origin of thorough-drainage; showing that for a century it has been used generally in the large and well-farmed counties of Essex, Suffolk, and Norfolk, as well as in Hertfordshire. But it does more; it gives us the power of improving other English counties in a cheaper and, I believe, a better manner than by the more modern processes of stone and tile draining used in the north—I mean on heavy clay lands. It is incomparably cheaper than either, and I think better; because some of the evidence shows, and I have heard and seen, that tiles alone will sometimes not draw off the water upon our heavy English clays, such as are hardly, if at all, known in Scotland. Filling drains with broken stones costs 7*l.* or 8*l.* per acre upon these clays, and the stone in many such districts is not to be found. I have tried this English method myself on 50 or 60 acres of extremely stiff land, which were drained for me last winter by the old Suffolk drillman Thomas Teago, whom I mentioned in the last Number. Our Berkshire labourers soon learned to use the Suffolk tools, which are excellent;* and these fields are now filled with drains at 11 feet interval and 30 inches of depth for the very low expense of 3*l.* per acre. I intend to drain the whole farm in the same way; and this discovery relieves me from a great difficulty, for the farm would hardly find a tenant without draining; yet to go over 300 acres of it with tiles would have cost at least 3000*l.* I must mention one item of saving in this process of the eastern counties, which has struck me very forcibly. I found that my drainer first traced out every drain with a common plough, opening the soil to the depth of 8 inches. He told me that he reckoned the saving of labour, and, consequently, of expense, effected by this simple operation at 2*d.* per pole, which amounts to 2*l.* per acre. Now many men have endeavoured to invent draining-ploughs, not one of which as yet has established its usefulness, yet here is a common practice of using the commonest and oldest of all implements, the plough, by which on one farm 600*l.* will be saved;

* These tools may be obtained from Mr. Teago of Peasenhall, Suffolk.

yet in no work on draining has this simple process been mentioned. It is a fresh instance of a truth which is not confined to farming, that we often seek in vain for something new and uncertain, while what is good and real is lying neglected at the door. The mode of ploughing out drains is clearly stated in Mr. Hill's paper, and is there shown to be carried still further by the use of a plough made for the purpose, with, I suppose, still further economy. His drawings will enable any one to follow the good example of the eastern counties; and I strongly recommend this practice upon heavy lands, as at once the cheapest and most certain to act. The only objection is its want of permanence; but it lasts from twelve to twenty years. Now where a whole farm requires to be drained, and the means both of landlord and tenant are limited, there can scarcely be a doubt which is best for both of them—to drain 100 acres for forty years, or 300 acres for twenty years. Besides, Mr. Rham has suggested that tiles might be used as carriers to the earth-drains; and I have no doubt these would add ten years to the durability of the draining: for the earth-drain does not fall in throughout, it only becomes choked in spots, so that by cutting a few new drains across the old ones, it is found that the field becomes once more dry. If an earth-drain be 300 yards long, a single obstacle may check the water to the full length; but if it be crossed by three tile-drains, each earth-drain will have a run of 50 yards only, and that length alone can be blocked by a single stoppage: so that the field would only receive one-sixth of the damage that would otherwise have arisen from a given amount of decay in the drains.

On looser soils, however, earth-drains will not stand, and here we must have recourse to tiles, the expense of which has hitherto been a serious obstacle to their employment. In the last Number I mentioned the great difference in their price in different parts of England, and I am glad to find that a reduction is taking place. Mr. A'Court Holmes informs me that last winter tiles cost 55*s.* and soles 30*s.* per 1000 in the Isle of Wight, while in Huntingdonshire the same articles were selling at 22*s.* and 10*s.*, at the same price of coals: large, however, as is this reduction, I have great pleasure in announcing to the Society a still further abatement of *one-third* below the Huntingdonshire scale; and, which is remarkable, from three different counties, by means of four different machines. I have taken pains to inquire into their merits, and the subject is so important that I need not hesitate to lay before the Society such accounts as I have obtained.

The first account was from Suffolk. The kind of tile is peculiar, being a pipe. The price of the pipe is 20*s.* per thousand (coals at 20*s.* per ton); and as no sole of course is required, we have at once a saving of 10*s.* in 32*s.* As the water can only

enter the pipes where they join, it was necessary to inquire into the result of the drains which had been so filled; and I have obtained the following statement from Mr. Hersey, of Framsdon near Debenham:—

“The quantity of straw or stubble used by us here in filling up our drains, which was about a load per acre, added to the expense, while it deprived the land of manure. The cost of draining-tiles, hitherto 2*l.* 2*s.* per thousand, was far too high to be adopted in the close method of draining we were pursuing. It was suggested that a plain tile with its two sides pressed together so as to leave a cavity of 4 inches by 1½ inch, would be sufficient. The late Mr. Pettit, of Winston, made some pipes of this shape at his kiln three years since. He afterwards made a machine by which the clay is forced through a box containing the die which forms the hollow of the pipe. The cost of these tiles, which are now in use, as made at the Winston kilns with coals at 20*s.* per ton, is, for Mr. Pettit’s 20*s.*, for Mr. Smith’s 20*s.* and 21*s.* per thousand. The price of Mr. Smith’s machine, which resembles Mr. Pettit’s in principle, will vary from 6*l.* to 8*l.*

“The tiles are laid in clay and other stiff soils at a depth varying from 26 to 30 inches, and the drains from 15 to 18 feet apart. The first spit, where it is practicable, is taken out with a plough, and the drain is opened by a narrow spade of 13 inches in length by 3 in width, with a scoop of the same length and width, to leave the drain perfectly clean. When the drains are 18 feet apart the expense per acre on strong stiff soils, including the tiles, is 3*l.* 12*s.*, which will vary a few shillings per acre as the soil is more stony.

“They were first used about three years ago upon strong clayey soils. The water flows as freely from those drains which are filled with the whole tiles as from those filled with the common tiles, or with straw or heath. Mr. Boby, of Willesham, has laid upwards of 100,000, and says they draw well; and several others who have used them bear the same testimony.”

Those who have paid 10*l.* or 12*l.* per acre for tile-draining at 18 feet apart, will see the great saving effected when the expense is reduced, as in Suffolk, to 3*l.* 12*s.* I perceive, on examining Mr. Kersey’s statement, that the whole saving is not effected in the price of tiles, but that the cost of cutting the drains, which commonly amounts to 4*d.* per pole, is also reduced one-half, amounting only to 2*d.* This further saving of one-half in labour is evidently effected by engraving upon the modern use of the tile the old Suffolk practice of opening the land with the plough, as described in Mr. Hill’s paper, which seems to me a certain and essential improvement.

The second account, which reached me at the same time through Mr. Reid, who commenced tile-draining in 1795, is from the county of Sussex. These tiles are also pipes; they are made at a kiln adjoining the Burgess Hill station of the Brighton Railway, with a machine which, as Mr. Wood informs me, need not

cost more than from 3*l.* to 5*l.* The pipes cost 20*s.* when burnt with brushwood. Mr. Wood has used them for two years, and has found them draw well. I have also obtained the following account of them from Mr. Hammond, of Penshurst, in Kent:—

“Penshurst, March 27th, 1843.

“As you wish to be informed of the expenses of draining with the cylindrical tiles, and my opinion of their effect, I have troubled you with this letter. Porous soils, with drains 3 feet deep, placed at the distance of 2 rods, in parallel lines up the field (and afterwards subsoil ploughed), will be completely drained at the following expense per acre:—

	£.	s.	d.
1350 tiles, at 21 <i>s.</i> per thousand	1	8	6
Cutting drains and laying tiles, at 4 <i>d.</i> per rod.	1	6	8
	<hr/>		
	2	15	2
	<hr/>		

“I have not included the expense of fetching the tiles, as that depends on the distance, but they are made light, so that we carry 7000 with one waggon.

“I am at this time draining on a stiff clay soil; the drains 2 feet deep and 24 feet between the drains—expense as follows:—

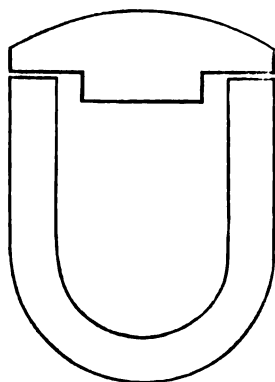
	£.	s.	d.
1850 tiles, at 21 <i>s.</i> per thousand	1	16	9
Cutting drains and laying tiles, at 3 <i>d.</i> per rod	1	7	6
	<hr/>		
	3	4	3
	<hr/>		

“I have this winter drained about 10 acres with the round tiles, and I am quite satisfied they act better than any other yet made, as they are not liable to be disturbed by moles or other vermin (which the other sorts admit), and can be laid with greater nicety in the drains than any other shape. The effect of draining I have experienced for twenty years, and am quite satisfied that no expenditure on the land will make so good a return. As the effect of relieving the soil of the stagnant water to the depth of 3 feet instantly admits the atmosphere, and what before had been inert soon becomes active soil, and the root will penetrate it; and rain afterwards will pass through the soil into the drains with beneficial effects, when before it was injurious.

“I am of opinion that the size of the tiles may be still further reduced with an equally good effect, so as to reduce the cost of making and carriage 15 per cent. lower.”

Mr. Hammond's remark that 7000 of these tiles can be carried in a waggon is not unimportant, as 1000 tiles form, I believe, the ordinary load, so that here is a great gain for the farmer's horses. The slenderness of the pipe-tile is also a cause of its cheapness, because a much larger quantity than of the common tiles can thus be burnt with a given quantity of fuel—one of the chief items in tile-making. But I am happy to say that our prospect of cheap

tile-drainage is not even limited to the Suffolk and Sussex pipes. Mr. Etheredge, of the Woodlands near Southampton, has invented a machine, of which the well-known house of Ransom, at Ipswich, think so highly, that they have purchased the patent;



and this machine makes tiles and soles both, or rather tiles and lids, (for the position, as the drawing shows, is reversed,) at the same reduced price as the pipes only, namely, 25s. per thousand of 15-inch tiles, or 20s. per 1000 feet, at the standard price of coals, 20s. per ton.* It will also make pipes at 16s. per 1000 feet—but we will say 20s. And I must ask our members to look at this advantage which our Society has effected. The same article which last November was selling in the Isle of Wight, where the clay lands greatly require it, for 75s., will now be procurable at

Southampton for only 20s. It is certainly a most encouraging circumstance, that as the necessity for draining is more widely acknowledged, its expense, both in material and in labour also (by the Suffolk practice), should be so greatly diminished. For use what arguments we might, while the cost was from 6*l.* to 10*l.* per acre, it was vain to hope for its general adoption. Fortunately too for the heavy clays, where the expense might still be serious, we find a simple ancient practice of our eastern counties, which brings our expenses again within bounds. It is therefore with great satisfaction that I lay before the Society estimates again greatly reduced below those which I presented to our members last autumn.

COST OF THOROUGH-DRAINING ONE ACRE :—

Distance between Drains.	Length of Drains in Furlongs of 40 Poles.	Number of Feet of Tiles.	Reduced Cost of Tiles and Lids, or of Pipes.	Making Drains 26 inches deep with Plough and Narrow Spade.	Total.
Feet.			£. s. d.	£. s. d.	£. s. d.
66	1	660	0 13 4	0 6 8	1 0 0
44	1½	990	1 0 0	0 10 0	1 10 0
33	2	1320	1 6 8	0 13 4	2 0 0
22	3	1980	2 0 0	1 0 0	3 0 0
16½	4	2640	2 13 4	1 6 8	4 0 0

* Mr. Etheredge informs me that his tiles do not require sheds to be built for drying them—another important saving.

The three distances of 44, 33, and 22 feet, costing now only 30s., 40s., and 60s. respectively, will generally be found sufficient in practice. The only case in which the stiffness of the land might require an expenditure of 4l., already points out that tiles may not be the proper material upon such land, and that we ought to have recourse to the tried practice of Suffolk and Essex, so well described by Mr. Hill, which again brings our outlay to a practicable standard.

COST OF EARTH-DRAINING ONE ACRE:—

Distance between Drains, in Feet.	Length of Drains in Furlongs.	Cost of Labour.	Cost of Stubble, &c., if required.	Total Cost.
22	3	£. s. d. 1 4 0	£. s. d. 0 6 0	£. s. d. 1 10 0
16½	4	1 12 0	0 10 0	2 2 0
11	6	2 8 0	0 15 0	3 3 0

It remains only for the owners, as well as occupiers, of land to practise the means of improvement which have been put in their hands. There is little doubt that the next winter will bring with it much want of employment for country labourers; but this evil may be remedied by landlords who will employ, in the lasting improvement of their own properties, those who stand unwillingly idle, only it is necessary that their stewards should exert themselves now and make preparations in time. For heavy clays I should engage a foreman from Essex or Suffolk well acquainted with the practice of land-ditching; for more loamy soils a tile-machine should be procured, in order that the tiles may at once be got ready for the season when they will be required.

V.—*On the Drill Husbandry of Turnips.—Prize Essay.* By
BARUGH ALMACK, late of Bishop-Burton, Yorkshire.

THE great importance of the turnip crop is now generally admitted, not merely as food for our flocks, but as the best groundwork hitherto discovered for the improvement of such soils as are calculated for its growth. He therefore who can add the smallest mite to the general stock of information regarding the cultivation of turnips is, in my opinion, bound to come forward and let others have the benefit of it.

The following observations are founded on several years of extensive practice on real turnip soil, on the wolds of the East Riding of Yorkshire; and where my remarks seem general, they

must only be taken as applicable to real turnip land, whether of the first quality or not. My observation has not been confined to different effects arising from different causes on land that was similar to that I had to cultivate; but having, from a very early age, a decided fancy for the cultivation of arable land, and particularly good opportunities of indulging it, I was a tolerably close observer of the modes of cultivation practised by my brother farmers, and the different effects produced, whatever the practice might be, or on whatever soil it was tried. I will leave others to inquire as to the time when turnips were first grown in England as a field crop, and go at once to the more important question, *How*—now that they have been introduced—they can be grown to the greatest advantage? I propose arranging my observations under the heads required by the Society.

I.—The Time of Sowing the different Varieties on different Soils, and at different Elevations and Latitudes.

1st. As a general rule, turnips may with advantage be sown at an earlier period in the north than would be suitable for the same species, with other circumstances equal, in the south. Thus, although in the East Riding it is common to commence sowing swedes the second week in May, and to finish white turnips by the 21st of June, in Suffolk it is usual to commence swedes near the end of May, and white turnips a month later.

2nd. The effect, however, of difference in latitude is partially counteracted by a greater or less degree of elevation, as well as by a difference of soil, *where other things are equal*.

3rd. As a general rule, the greater the elevation of the ground the colder is the climate; therefore, if this is not counteracted by a difference of soil or situation, the high ground of the south will have a climate somewhat similar to land in a more northern latitude, at a less degree of elevation, and should be sown accordingly.

4th. Some soils are naturally of a colder nature than others, and a difference in this respect will counteract what is known to be the common effect of any given elevation or latitude.

5th. Any peculiarity of the soil or situation which tends to promote rapid growth and quick maturity will render the land less suitable to be sown early. Thus we see that, although there is said to be a general difference of about three weeks in the proper time for sowing, between the north and the south of England, the occupiers of the hills in Gloucestershire find it desirable to sow about as early as those of the wolds of Yorkshire; also those of some of the rich and low grounds of the East Riding sow about three weeks later than their neighbours on the

wolds not ten miles from them, and consequently nearly three weeks later than those on the hills of Gloucestershire.

Similar deviations from those general rules may be met with in most districts where the soil, aspect, or elevation, vary as above alluded to.

The proper season for sowing all the common varieties of turnips does not usually extend over much more than six weeks in any given district.

Swedes are generally sown first. "Hybrids,"* being partly of the same nature, are usually sown next, and white turnips the last, especially if they are intended for late consumption. When for early use, they, as well as the other species, may with advantage be sown at an earlier period.

The more solid the texture of the turnip, *as compared with others of its own particular species*, the more suitable it will be for late consumption, and consequently for late sowing.

To exemplify this, it is only necessary to say, that the "white globe," which, from its quick growth and large size, is highly valued for early consumption, is, by the same peculiarities, unfitted for standing over winter.

In districts where about one-fourth of the arable land should each year be sown with turnips, there is necessarily more work for the horses than could be done within the period best calculated or producing the heaviest crop. Therefore the occupiers, through fear that they might be driven into a late season for part of their land, and then perhaps be almost compelled to sow in unfavourable weather, with scarcely the chance of obtaining a productive crop, will seize on the earliest period, *when the weather is favourable*, at which a given species of turnip has been sown in that situation with success.

The chances of a heavier crop are so far in favour of what is considered early sowing, as to justify in this case a little risk of being too early, in order to secure the positive benefit of a commencement under favourable circumstances.

In districts where the occupiers are most dependent on their turnip crop, from want of good grass-land, it is of great importance to spread the advantage of having turnips over as long a period as possible: thus, some will sow part of their white turnips before swedes.

* The cultivation of "hybrid" turnips has extended rapidly within the last few years, especially on deep, light wold land; such land is not well calculated for white turnips, and, if sown with swedes, it would require a greater quantity of manure to produce an equal crop. "Hybrid" turnips retain their nutritious qualities longer than white turnips, and although not so long as swedes, they are better adapted for consumption immediately after white turnips.

This very early sowing of white turnips might be ruinous to the crop, were it intended to stand over the winter, but for early consumption *may have* every recommendation. I say *may*, because everything must depend on the weather of the season in question. Thus, until we have an assurance that successive years will be counterparts of each other, no man can accurately foretell what period of sowing will have the best effect in any given situation.

That climate which by its warmth enables the occupiers of land to sow "stubble turnips" with success has the drawback of rendering turnips more liable to mildew from too early sowing.

When turnips are sown *too* early, there will also be danger of their growing too much "into top" during the autumn; and, if they are sown *too* late, the crop will be light; even a few days will make a great difference in this respect.

II.—*The Mode of Preparing the Land and of Drilling the Seed, with a Description of the Implements used.*

Although there are many intelligent persons in different parts of England, especially in the southern counties, who, after having given what they considered a fair trial to drilling, both on ridge and level, have returned to the old broadcast system, yet drilling is now generally admitted to have advantages over broadcast of sufficient importance to justify the additional expense attending it; and these advantages appear to be,—

1st. By drilling the seed with the manure, they at once come in contact, and must be more likely to insure a crop, than when the manure and the seed are each spread at random, to take their chance of falling sufficiently near each other for the former to benefit the latter.

2nd. The land can be more effectually cleaned, and at a cheaper rate, by the use of the horse-hoe.

3rd. The land will be much benefited by the use of the horse-hoe, independently of the cleaning before alluded to.

4th. The seed can be put in more uniformly at what may be considered the proper depth.

5th. When drilling is neatly performed, it shows good cultivation to the best advantage. He, who has once had his fields pointed out as models of garden cultivation on a large scale, will spare no labour to maintain his character; and his neighbours generally will soon be ashamed of appearing to disadvantage by the comparison.

I believe few of the advocates of drilling are aware how many have tried the system (as they thought fairly), and given it up; but, in my opinion, this has arisen, in almost every instance, from their not having tried it on its own peculiar principles.

To manure on level, broadcast, and then drill the seed in rows, is no fair trial of the drill system ; but some have laid drilling aside after such a trial. The most ardent advocate for drilling could not reasonably expect to grow the best turnips merely because the seed was sown in rows : that, to a certain extent, is an advantage, but the drill system is not fairly tried, unless the manure and the seed come in contact *in the rows*, and such means are adopted, in other respects, as tend not only to prevent these advantages being counteracted unnecessarily, but enable us to make use of all other advantages *peculiar to drilling*.

As I shall in some cases recommend the system of drilling on level, although in Scotland ridging is almost invariably practised, I feel it due to the character of the people of that country, so eminent as a body for their intelligence and good sense, to go fully into my motives for so doing.

In July of the very dry summer of 1826, the prospect as to the turnip crop was indeed melancholy ; there were few persons in my neighbourhood who were likely to have, or, as the event proved, who had, any. *At that period the ridge system was almost invariably followed on the wolds of Yorkshire* ; and, out of about 200 acres of turnips, in which I at that time was more particularly interested, all, except about 5 acres, had been ridged ; as these would have been also, had not a fortunate chance interfered to prevent it. The piece of land in question was of a triangular shape, with a deep valley running through it, rendering it very unsuitable for ridging. From these and other circumstances it was drilled level ; and the crop *on it* proved a very good one, whilst the remainder of the field bore scarcely any turnips at all. The ridging system was so little more successful in the other fields, that it was calculated there had been about 300% worth of bone and other manure thrown away.

This was rather a sharp practical lesson as to effects, and it was not necessary to look far for causes. The soil was thin, and rested on chalk ; therefore, particularly liable to be injured by drought. The ridges, by constantly having the sun on three sides of them, had become as dry as if they had been baked in an oven. Any person, who examined them closely, would as soon expect to get a crop of turnips out of the mud-walls of past ages, as from ridges *in that situation* during such a season as the one I speak of.

Having thus seen what serious consequences might in some seasons arise from practising the ridge system, in addition to loss by sheep getting laid on their backs betwixt the ridges, as well as the extra trouble attending it, it became necessary to consider whether there were any advantages arising peculiarly from that system, sufficient to justify running the risk of the ill effects just mentioned. After much consideration, I became of opinion that,

for white turnips, on thin and dry soils generally, and particularly in such high and dry situations as the wolds of Yorkshire, where the soil is generally thin and resting on chalk, the balance of probable advantage was decidedly in favour of the level* system, if it was only intended to apply, under either system, such manure as could be done by drill.

The advocates for ridging said, "If we are to apply farm-yard manure, we must ridge, or we cannot derive the full benefit of having so manured: in addition to which, turnips are so much better to clean when ridged."

Now, where is the advantage of having manure within ridges, if the soil above it is so dry as not to allow the plants to grow to such an age as to benefit by that manure?

Suppose we admit that, if you were sure of plenty of plants surviving until ready to hoe, you might in some cases get a heavier produce by ridges than on level, through applying farm-manure, &c., it does not follow, as a matter of course, that it would be a more valuable crop per acre; because, when white turnips get beyond a certain size, they deteriorate in feeding qualities, especially if not consumed early in the season. At the same time it was argued, and since then has been abundantly proved, that white turnips may be got as large as it is desirable to have them for sheep, by drilling level, with the rows from 18 to 22 inches apart, without farm-yard manure; whereas, ridging is generally performed at about 27 inches. It therefore follows, that if at about 20 inches apart you can get rows of as good turnips, as under the ridge system at 27 inches, there is a bonus of 7 acres in 27 in favour of the former, in addition to the greater certainty of a sufficiency of plants.

As to the advantage in cleaning the land, this may be attained for the level system by clearing it of weeds, and the seeds of weeds (as I shall hereafter show), previous to the turnips being sown. Besides, by having the level-drilling performed in a straight and workmanlike manner, the land will be nearly as good to scuffle as if it had been ridged; therefore, none of the numerous benefits derived from the frequent use of the horse-hoe need be lost by having the rows thus drilled on level.

From that time the use of farm-yard manure for white turnips was abandoned by me and some of my neighbours, as a consequence of adopting the level system of sowing.

Swedes require not only a greater depth of soil than white turnips, but richer land, or more manure; therefore, the chances in

* The level system has been also partially adopted these twenty years on the light lands of the south, from the causes here mentioned; and swedes and white turnips, raised by artificial manure, alone deposited by the drill.—G. KIMBERLEY.

favour of the level or flat system for swedes are not so great; and I am prepared to admit, that a heavier crop of swedes *may* be got by ridging (in favourable seasons for that system) than on level. But, after well weighing the chances, I generally sowed swedes on level; and some of the best farmers I know yet do the same—preferring what amounts to *almost a certainty* of a good crop to taking a more expensive and tedious process for a small chance of a better, with the risk of *no crop at all*.

For land of rather a wet nature, ridging has recommendations which it has not for that which is naturally dry—the spaces *between* ridges become a species of surface-drainage, and the farm-yard manure *within* them will have a similar tendency, which not only accounts in some degree for the ridge being more suitable for wet than for dry soils, but partly explains why longer manure may be used with advantage, on the former, than such as is considered proper for the latter. Again, the spaces also serve as a sort of railway for the carts, &c., used in sowing the crop, as well as consuming it; thereby partly preventing the injury which such land is liable to, from being “poached” in wet weather.

The same process of treading the ground whilst consuming the turnips, which is so beneficial to thin light soils (except in extraordinarily wet seasons), is generally injurious to strong soils; so that, in every case, our practice must be regulated to a great extent by what is peculiar to the situation.

He, who lays down general rules, as applicable to every variety of situation, will in my opinion only mislead those who place implicit confidence in him. I think we are only justified in stating such general principles, as extensive observation may have pointed out, and offering them for the consideration of those who may have had less experience, accompanied with the caution to reflect well, how far they are applicable to their own particular soil and situation, and to regulate their proceedings accordingly.

The turnip crop being considered not only as a means of supplying our cattle and sheep with food, but as a preparation for future crops, by cleaning the land and enriching it; these several objects must always be borne in mind whilst preparing the land for turnips.

As complete a pulverization of the soil to the depth at which the plough usually goes as the season and the nature of that soil will allow, so as to admit the free circulation of the air to that depth, is one of the first essentials. Where the soil not only admits complete pulverization, but will at the least expense grow the heaviest crops of the most valuable varieties of the turnip, with the greatest permanent benefit to the land by the preparation for the crop, and the consumption of it, whether on the land where it was grown or otherwise, we call this the best turnip land.

It might appear almost unnecessary to state this, were it not, that, in preparing any land for turnips, we must constantly bear in mind in what it differs from "the best turnip land," and let our preparation for the crop, and our consumption of it, be regulated accordingly. Real turnip soil, although not of the best quality, may by high cultivation produce crops approaching, if not equal, to the best turnip land.

I have always recommended the first ploughing to be done as early as possible, whether immediately after corn, or where old grass is broken up for turnips. I have broken up grass on more than one occasion, and my experience has tended to convince me, that in many cases, where the land is in such a state as to be capable of being thoroughly broken up and pulverized, without first paring and burning, it would be best to lime the grass immediately before ploughing, not only that the lime might assist in decomposing the vegetable matter, and thereby turn to manure what would otherwise to a certain extent be wasted, or reduced by the process of burning, but that the lime, by becoming incorporated with the soil, might cause the land to work more freely, and thereby mechanically assist in all the future operations. For similar reasons I have used lime on corn stubbles before ploughing for turnips, and think that it is generally the best period for doing so, especially if the land is foul, or if animal manure is intended to be applied for the turnip crop. Were the lime and the animal manure to follow each other too closely, the former might counteract the beneficial effects of the latter, instead of being, what I think in most cases it ought to be considered, rather a preparation for them.

We now come to the point where it is necessary to consider whether the land is subject to weeds, especially "charlock." I can remember the time when every one I talked to on the subject used to say "it was quite impossible to guard against having charlock in your crops, because you never could get rid of it. If you dug into the earth 20 feet, to make a canal, &c., the soil coming to the surface from that depth would immediately be covered with it."

I must confess that this fact for some time seemed to throw an almost insurmountable obstacle in the way of effectually preventing the growth of the weed; and I believe that to this day there are many who therefore never think of guarding against it, except by destroying what grows in their corn, &c., considering it a hopeless task.

From the magnitude of the evil I feel justified in calling particular attention to this subject. Having once accounted to myself satisfactorily, for the charlock-seed not growing at 20 feet deep, and growing at once when brought near the surface, by the

simple reflection, that of course it could not grow where it was entirely out of reach of the circulation of air, and that the same absence of air which prevented seed from vegetating, might still *tend to preserve its vegetating quality*, until brought under more favourable circumstances for calling it into action, I at once came to the conclusion that, if I cultivated the land so as to cause all the seed to grow that was within the circulation of the air, or usual ploughing depth, and, after the seed had grown, destroyed the weeds by ploughing the land, I should by that means get rid of all cause for apprehension on their account until I ploughed deeper. I therefore invariably acted on this idea, experience convincing me of its correctness; and I can now say that, under favourable circumstances of the turnip-fallow season, for getting the seed grown, it is a most effectual remedy.

In the summer of 1830 a most favourable opportunity presented itself for putting my theory to the test. One of the fields I had to sow with turnips that season had always been much subject to growing charlock, therefore I determined to make the whole of the seed, within the depth of the first ploughing, *grow*, and, having grown, to destroy it of course before the time I wished to sow the turnips.

The first ploughing was done early in the autumn, as I have before recommended. The next in the first period after Christmas, in which the land seemed sufficiently dry for the purpose; this was of course across the other, it being well known that on light soils with dry substrata, it is better that each succeeding ploughing, or dragging, should be taken in a contrary direction from the preceding one. In a short time the land became sufficiently dry to harrow and roll; it was therefore immediately harrowed with common harrows, closely followed by the drag-harrow with its broad set of teeth, there being no couch in the land; then alternately harrowed and rolled, each operation following as closely on the other as practicable, until the soil was as thoroughly pulverized as possible, so that the seeds of the weeds might thus be more likely to grow.

After a few days the charlock sprung up so thickly, as nearly to cover the whole surface of the land. I allowed it to grow to about 2 inches in length, and then had the land again dragged with the drag-harrow as before, the common harrows and roller again following each other as closely as possible; and the field was soon prepared for a second crop of charlock. A second certainly soon came, but it was a very thin one in comparison with the first; I had evidently caused the greater part of the seed to grow at once.

This process was repeated for the third time, the crop of charlock still diminishing; and when, after the *fourth* working, I sowed

the turnip-seed, it sprung up quickly; and I had the satisfaction to find these weeds were so effectually destroyed, that it would have been difficult to find two within 50 yards of each other, although in the first crop there had been so many. I do not mean to say that, if this field were ploughed deeper than it was in the season I allude to, or soil brought to the air that had not before been within its reach, charlock would not grow, but I can say, it never has grown since, although there have been several charlock years. However, no doubt, there are occasionally seasons so unfavourable for getting the seeds of these weeds grown, that no man could at once get rid of them; therefore, we must not throw discredit on those who have not had a fair opportunity of preventing what is probably a source of great annoyance to them.

When the proper moment is seized for performing each operation, of harrowing, rolling, &c., which, in dry weather, and on dry soils, will generally be found to be by causing them to follow each other closely—that is, before the land gets too dry—the work of pulverization and cleaning will be found to take less labour than might at first be supposed.

I have thus, partly, stated my method of preparing land for turnips, when clear from couch, and yet subject to charlock. Considerable experience on land much subject to couch taught me, that the best time to get it out is after the second ploughing, and then by the drag-harrow. If you plough oftener before you make the attempt, the couch will be cut into such small pieces that it will be very difficult to get rid of the whole.

When the land has been made fine, the couch of course must be raked off, and either burnt or turned into manure without burning.

If it is burnt, the ashes should be drilled with the other manure when sowing the turnips, in order to accelerate the growth of the young plants, which they will do in a remarkable degree. But, whether the couch ought to be burnt for this purpose, will depend on whether we have any cheaper means of attaining the same end.

Were it not for the advantages from drilling the ashes as above, I think it would be better not to burn the couch.

Where the soil is very full of couch, it will be necessary to have the small teeth in the drag, or it would not pass through it; but, when larger teeth can be used, they are much more effectual.

The couch will not all be got out by one dragging, but, if the season is then favourable, it is best to cross-drag it until you have got rid of the whole.

The system of close working with harrows, rollers, &c., may not be equally applicable to all soils, but as there is a “tide in the affairs of men,” so there is a time for performing each opera-

tion, on every variety of soil, which ought to be watched and turned to advantage.

When the soil is most completely pulverized, it is in the best state for retaining moisture, whilst clods are so soon dry that they are almost emblematical of dryness. It is very generally admitted that the land must be well pulverized to have a good chance of a crop. I venture to say, that in dry weather it cannot be made too fine; but, where there is a probability of rain *on land recently tilled*, we should leave it rougher, or, in some cases, in whole furrows, that the rain may penetrate it without the injurious effects that would follow a heavy rain on recently powdered soil.

For the same reason it will be necessary to be cautious in the use of very heavy rollers; they are occasionally useful, but I have known them injurious. It will also be necessary to avoid harrowing the land when wet. Some, to prevent the time of the men and horses being wasted (as they call it), employ them in doing what, *at that time*, is worse than useless.

The point to aim at seems to be *clean* ground, and as complete pulverization as the nature of the soil will admit, with the least risk of being caught by heavy rains, in such a state as to cause the land to *set* and run together, which would at once check the advantages derived from the circulation of air, &c., in the porous soil, and render it necessary to repeat the work of pulverization. To attain this on some soils, and in some seasons, is a very difficult task. We sometimes see very good turnips, on what cannot be called turnip-land; and more, that they are consumed on the land with evident advantage to it, whilst an attempt has been made by a different person, on similar soil in the adjoining field, and proved a complete failure. Chance may occasionally have something to do with this, but the difference generally arises from the degree of skill possessed by the cultivator.*

The manner of making turnip-ridges is so well known to every intelligent ploughman, and has been so often described in the Society's Journal and elsewhere, that it is not necessary to repeat it here. It may however be as well to state, that, in making turnip-rows, it is requisite to have a light straight piece of wood between the heads of the two horses, by being fastened to or near the bit of each; it keeps them at a regular distance from each

* Since the publication of the valuable accounts of experiments on Yard and House Feeding of Sheep, by Lord Western and Mr. Childers, M.P., showing that these animals will not only do as well on turnips brought from the land, but may by that means produce a much larger proportion of mutton for the food consumed, one great objection to an extended cultivation of turnips on soils liable to be injured by the treading of sheep is removed; therefore it is desirable that all occupiers of such soils should have their attention drawn to these reports.

other; and if the horses are accustomed to draw together, and are of the same speed, they may thus enable the ploughman to do his work in a superior manner, the importance of which will be hereafter seen when I speak of the drilling.

Although in the East Riding it is more common to use waggons in laying on farm-yard manure, I am inclined to think carts, when used as described by Mr. Grey in our Journal, answer better, because likely to save time, a matter of the utmost importance. I account for this supposed inferiority of the East Riding, as compared with Northumberland, by their now ridging so little. Where a certain work is most practised it is probable it will be best understood; and many of the East-Riding farmers having almost given up ridging (as I have stated), it is a matter of comparatively little importance to them how manure is best put on ridges. If the cart method described by Mr. Grey usually tends to economize labour, the more tedious one certainly ought not to be followed, because it is universally admitted by all good farmers, that it is desirable *the whole of the operations*—from the forming of the ridges to the covering of the seed—should be completed in as short a space of time as possible. Whether on ridges or level, where many turnips are sown, the large drill (or drill for general purposes) is used in sowing turnips in the district I have named, although in some instances, where no manure is drilled with the seed, the small “barrow,” or Scotch drill, is used for ridges. It has often been stated, that the latter only is applicable for ridges, but that is a mistake. Where the ridges are not at regular distances, or not straight, of course it would not do to drill more than one row at a time, for the obvious reason, that the spout of the drill would not always be on the centre of the row. But, if the rows are perfectly straight and at the same distance from each other, that distance being such as will allow the drill to cross two of them, the wheels running exactly in the centre of the channel, and one wheel returning on the same place (already marked out by itself), whilst the other goes on the outside of two more rows, the large drill will be found applicable, and it has the advantage of enabling you to drill some manure with the seed. However, the small drill, being more under command of the man who follows and guides it, is certainly more adapted to putting the seed at a proper depth. Whether sown with the large or small drill, ridges are usually rolled before and after drilling, to secure a fine mould and more uniform depth. In using the small drill, only one horse is necessary for the roller and the drill, the horse being attached to the former; the roller covering two rows at once, each row is rolled both before and after drilling.

These preceding operations having been regulated with due regard to retain moisture, and to cause a full and rapid growth at

the first stage, it may not be amiss to remark, that, the more thickly you sow the seed (other circumstances being equal), the more rapidly the young plants will run each other up, as it is with young trees in a plantation. If we were certain all the seed would grow and arrive at the state for hoeing, it would only be necessary to sow a very small quantity; but, as there are numerous risks before the plants are ready for hoeing, prudent men will adopt the most secure method, and not risk their capital, even if they know some instances of fortunate results on soils of a peculiar nature, or in particularly favourable seasons, by using only a small quantity of seed. I used to sow from 4 lbs. to 5 lbs. per acre for swedes, and from 3 lbs. to 4 lbs. for white turnips, and even greater quantities where I sowed early in the season.

For level sowing it is also desirable to have the seed covered as closely after the drill as practicable, in order to retain the moisture then in the soil, and to prevent the risk of less favourable weather. Some do this by rolling; but if heavy rains follow, especially immediately after the land is sowed, the flattened and compressed surface will not admit it so freely, but cause the soil to set and run together. Some harrow with common harrows, but these, even in favourable weather, are apt to remove the bones or other drill manure which may have been used. Others, knowing the danger of adopting either of these methods, leave the seed to take its chance of being covered by the loose soil that may (or may not) fall upon it after the drill, thinking that, if the seed get covered, the more thinly the better. This would be very plausible, if hoeing had not to follow, which must remove some of the surface soil; therefore, if the manure lies close to the surface, the turnips cannot be *hoed* without removing it also. After observing the disadvantage of each of these methods, I had some new harrows constructed. That they might be light, the "bulls," or parts to contain the teeth, were made of dry foreign pine, and the "slots," or cross-pieces, of thin ash of the best quality; the teeth being short and light, in fact not much larger than "tenpenny nails."

Two of these harrows hooked together, when in use, by common gate-loops and hooks, were very easily drawn by one horse, and took a breadth of about 8 or 9 feet; thus only one horse's foot-marks came where, by using common harrows, those of three horses would have been, which in damp weather is of great importance.

These light harrows not only answered my expectations, but proved that they had advantages I had not anticipated: they left the land with a more even surface than other harrows had done, causing it to resemble a flower-bed when newly broken by a garden-rake. This tends much to promote the growth of all the seed at once, and proved so advantageous to turnips, that I after-

wards adopted the use of these harrows when sowing grass-seeds in corn.

I soon had an opportunity of witnessing other advantages of these light harrows, as compared with common ones. I had drilled several acres of turnips without making the harrows follow the drill, as the ground was then rather too wet; but, instead of becoming drier, a heavy rain came on, and nothing could be done to the land for two or three days. At the end of that time I had it harrowed with the light harrows, and, as this did not take out the drill-marks, it was again harrowed with them the next day, which put it into a very good state, and from that time the turnips grew so well that they eventually were considered the best crop in the neighbourhood that season. An adjacent field, treated in every way similar to mine, save that it was harrowed by the common harrows instead of the light ones, had so few turnips in it that it could scarcely be considered one-fourth of a crop. The superiority of the new harrows was thus so apparent, that the use of them spread in the neighbourhood.

Another means of causing the plants to grow more rapidly at first is, to roll the land the first time it is in a favourable state *after the turnips are out of the ground*, taking care, of course, to do this *along* the rows, and not across them, or you would bury part of the plants.

When ridging was more common with my neighbours than it is now, one of them had got some land ridged for swedes, and was caught in this state by rather damp weather—that is, not sufficiently wet to stop the manuring, splitting the rows to cover it, &c., nor to prevent the turnip-seed being drilled, although too damp to allow the land being rolled after the drill: he therefore went on drilling with the hope that the weather would clear up and become dry, thinking, that if it did, he would have had an excellent turnip season. But, during the second day, the rain came down in torrents, making the land so wet that nothing could be done to it for several days, and when it had become dry it was too late to adopt the usual means of covering the seed—part of it had grown. About a fortnight was allowed to elapse after the plants appeared, to see the result; because, during that period, it was very difficult to say what would be the best course to pursue. The land having been very finely pulverized before ridging, and the seed drilled rather deeply, the furrows or channels in the ridges seemed like the bottom of a dried-up pond, with scattered turnip-plants, few and far between, no larger than they had been the last ten days, but less likely to grow because there were flies on them, basking in the sun and sheltered by the walls of hardened soil on each side of them. The land was cracking with sudden drought, and thus tending to retard the growth of the turnips;

but weeds, being of a more hardy nature, were both abundant and flourishing. In this state, as nearly as I can describe it, I found the field when my friend did me the honour to ask my advice as to the best means to adopt with respect to it. By my direction a number of men were immediately set to chop off the sides of the ridges with turnip-hoes, so as to reduce them to a level with the turnip-plants. The turnips were then *rolled*, which broke the soil around them to powder, and made the plants stand out clear of the ground, and *exposed to the wind*. The spaces between the rows were then scuffled, and the field at once presented a neat and clean appearance. The beneficial effect of the plan here adopted exceeded my most sanguine expectations, and certainly was a matter of great surprise to all who witnessed it.

The rolling (which could not have been done before the banks of the rows were taken off, without burying the young turnips) not only put the soil in a better state, fastening the roots of the plants in a fine mould, but *exposed the turnips to the wind*, which accelerated their growth not only by blowing them about, but by *removing their greatest enemies* the flies, which, I have observed, are generally found *in sheltered situations or hollows in the soil*.

After the process above named, it was evident that the means used would be highly beneficial, and in the two following days the plants grew more than in ten days before: in short, they were soon ready to hoe, and, by choosing a short period of damp weather to transplant a few, the field became a very excellent and full crop.

From having seen the great and various benefits derived by this almost accidental *rolling of plants* on ridges, I adopted the practice of rolling them on level, when the season was favourable for that purpose, and can strongly recommend it for the above reasons, not only as having been my own practice, but as now followed by others, whose opinions are entitled to the highest respect. The roller used for this purpose was of oak, and about 9 inches diameter, divided into two pieces, to render it suitable for turning about, as well as to press the land more uniformly. It had shafts, and was drawn by one horse, although made as long as could go through a common gateway. The *description of roller* used is of great importance, for our object is, to obtain a *decided and uniform effect on the surface, without fastening the soil too much below*.

Previous to hoeing, it is desirable to have the land horse-hoed, as closely to the rows of plants as practicable, that the hoers may have directions to clean all the ground of weeds which has not been cleared already by the horse-hoe.

When the weather is favourable, horse-hoeing will not only be

useful in clearing away the weeds, but *will make the turnips grow more rapidly*, both before and after hoeing; therefore, whether there are weeds or not, where it is of great importance to have the crop as forward as possible, this operation can scarcely be too often repeated so long as the work is properly done.

III.—*The kind and quantity of Manure employed.*

Bones have been the most common manure of late years for turnips on the wolds of Yorkshire and Lincolnshire; and probably few have better reasons for speaking highly of their effects than myself: but, as it is now well known there are several other manures which may be substituted, it is not my intention to particularly recommend them. Their price has regularly advanced from 2s. to 3s. per bushel; and if the demand for them thus yearly increases, it will soon become questionable whether their beneficial effects may not cost more than they are worth. I therefore most sincerely hope that some, out of the numerous manures mentioned as substitutes for bones, may prove as valuable as their patrons expect or wish. It is here necessary I should observe, that I cannot say how many tons of turnips per acre I have grown, simply because I never weighed any, nor had any weighed. There are, I know, many who have been celebrated for growing good crops of turnips, but yet never weighed a bushel. I consider the question I ought to enter on now is, not how much weight of turnips land *fresh to them*, and with other circumstances *peculiarly* favourable, *may* produce, nor what manure has the most beneficial effect on the turnip-plants, as so many new manures are introduced almost daily, that the question of their comparative value would be sufficient for an endless essay in itself. The great question for present decision is (or I think ought to be), *what modes of cultivation* are the best adapted for insuring such crops of turnips as are desirable for the broad fields of Britain, in order to afford the *greatest and most certain value* in nutriment to cattle, sheep, &c., and to render the land best capable of producing valuable future crops. I have got excellent crops of turnips by bone manure; also by mixing pigeons' dung and half-inch bones of equal quantities, and drilling 24 bushels on ridges 27 inches asunder, for swedes. From 1826 to 1834 I used to drill white turnips on level, using half-inch bone manure at the rate of from 16 to 24 bushels per acre, mixing with the bones the ashes of couch, &c., for the reasons before stated, the rows being generally 18 inches asunder. Swedes are well known to require more manure than white turnips, and it is usual to give them about half as much more. In 1839 I had an opportunity of observing the effect of a small quantity of rape-dust mixed with the bone-manure. I intended to sow a field of 47 acres with white tur-

nips—the rows 19 inches apart—to test my previous opinion that I could get nearly as good rows of turnips at that distance as at a greater; the manure per row being equal. Therefore, as it was then common to sow 18 bushels of bones per acre where the rows of white turnips were 22 inches apart, for my 19-inch rows I added three bushels of rape-dust, and drilled this mixture of 21 bushels per acre, being in proportion to the increased number of rows. When about two-thirds of the 19-inch field were sown, I found I could get no more rape-dust, therefore the remaining part was drilled with bones only, at the same rate—21 bushels per acre. Where the rape-dust had been used, the 19-inch rows of turnips were decidedly better than the 22-inch rows, and so much better than the part of the same field drilled with bones only, that it was quite unnecessary to mark the division. It will be observed that the proportion of rape-dust to bones was small, and I do not recommend a larger quantity of rape-dust.*

IV.—*The Distance between the Rows.*

I find it is now more common with some of the best farmers in the neighbourhood where I lived to have the rows of white turnips on level at 22 inches asunder, “because they are better to clean:” that is, any common ploughman may scuffle them at 22 inches; whereas it takes a choice workman to do them at 18 inches, especially if the rows are not quite straight. I had for several years a servant who was at that time considered the best leader of a drill-horse in the county (although I have since known three or four equal to him), and I had therefore little difficulty in getting the rows properly scuffled or horse-hoed, although only 18 inches apart. I considered I could, when the

* In that part of the East Riding called the North Wolds, an opinion is rapidly gaining ground in favour of applying bones in smaller quantities than formerly, from observing that this may be done without any apparent injury to the turnip or succeeding crops. As an instance of the evidence to this effect, a gentleman used bones for several years on his own land, at the rates of 12, 14, 16, 20, and 24 bushels per acre; and, during the same period, on land which he rented, he used only 10 bushels per acre; yet he could not grow any greater weight of turnips on his own farm than on the other, where he used the smaller quantity of bone-manure.—B. ALMACK.

This may be accounted for by the fact that bones contain only one or two of those constituents that compose the food of plants, and that a much less quantity of them than above mentioned would give to the land a sufficient quantity of those constituents for the turnip-crop. We may as well expect to support all animated nature on one substance, as to expect to arrive at perfection either in the quantity or quality of our crops by manuring them with any material that contains only one or two of those ingredients that constitute the food of the vegetable world.—G. KIMBERLEY.

soil and the seed were favourable, get very nearly, if not quite, as good turnips in each row at 18 inches asunder as at any greater distance, supposing the quantity of manure *per row* to be equal. I have seen no good reason for changing that opinion; indeed, experience has confirmed it. I was once induced to try part of a field with rows on level at about 27 inches apart, using the same quantity of bone-manure *per acre*—that is, more *per row* in proportion to the greater distance they were apart—When the sheep had eaten all the turnips in the field, I asked the shepherd what he thought of the wider rows, he replied, “he did not like them at all, he had his nets to remove too often.” This observation coincided with my own opinion of the crop.

As a proof that, on some soils and in some seasons, white turnips may be got as large as it is desirable to have them for sheep, with the rows only 18 inches apart.—I have occasionally seen crops sown at that distance which were said to have only one fault—they were “rather too large for sheep.” This case, however, would seldom occur. Some *species of turnips* have larger tops than others, and some soils *will, from the same seed*, grow larger tops than others: different manures also have each their peculiar effect in this respect. The larger the top of the turnip is likely to be, *from the nature of the soil*, the greater will be the space requisite for bringing the bulb to perfection. The large turnips obtained by 18-inch rows, before alluded to, were only seen on some particular fields, and always on soil and from seed peculiarly adapted to producing small tops and large bulbs. Thus it is necessary to take every peculiarity of soil, manure, and species of turnips, into consideration before we can properly decide at what distance the rows ought to be. Of course we must bear in mind the particular purpose for which the crop is wanted; for, where turnips are intended to be drawn off for cattle, it may be desirable to have them larger than when for consumption on the land by sheep. For details applicable, in consideration of this subject, I beg to refer to my calculations as to the comparative size and value of turnips of different diameters when speaking of the hoeing.

Some think that turnips drilled on level cannot be horse-hoed at all; and, as the difficulty certainly increases as you diminish the distance of the rows from each other, it may have been in some instances desirable to have the rows of white turnips more than 18 inches apart. But, as there are now drills said to be adapted to make straight rows on level, with only common skill in the drill-horse leader, that difficulty may to a certain extent be removed. It has been said, also, that, where the rows are wider, the sheep do not soil their food so much; but this disadvantage of 18-inch rows might be overcome by drawing every other row

for cutting into troughs. However, it must be admitted, that what may be good policy in some cases would not do in others, and that this will be considerably affected by the relative demand for labour, as well as by the abundance or otherwise of turnip-land.

I had observed that, although swedes require deeper and richer soil than white turnips, this could not be the only difference they needed, because I *never* saw good swedes grow near a high hedge, although, by the sheep lying there, &c., the hedge-sides are generally the richest part of the field. On the other hand, if you sow white turnips they will be larger as you approach the hedge—as a *consequence of the richer soil*—just about in the proportion that the swedes become smaller *notwithstanding the richer land*, because, as I concluded, they require more air than white turnips. I therefore used to drill the swedes in rows about 27 inches apart, whether on level or ridge. For the reason above given I used to sow the *outsides* of the fields, especially where the hedges were high, with *white* turnips, thereby gaining an immense quantity of turnips, which, from the richness of the soil, could all be spared for drawing off and consuming elsewhere, from land which, if sown with swedes, would scarcely have had any produce.

I observe Mr. Grey, in his able report of the state of agriculture in Northumberland, says, “Swede turnips, with dung, are sown upon drills of the width of 27 inches from centre to centre, and white turnips on drills from 28 to 30 inches, with bone-manure; and, for spring food, a width of 26 inches is sufficient.” From this there appears reason to suppose, that the farmers of Northumberland think white turnips require more room, in order to attain the proper size* (I will not say the heaviest produce per acre), than swedes do.

My own opinion I have already given. I fully agree with Mr. Grey in the following passage:—“A large weight cannot be produced but from large bulbs. A moment’s consideration will show that the last inch in the diameter of a large turnip will of itself be equal to several small ones: even in this, however, a medium is to be observed; for very large turnips, if not consumed early, do not stand long, and are inferior in nutritious quality.” I would also add, this deterioration in quality, as the size becomes large, is *much more observable* in white turnips than in swedes.†

* Because, in Northumberland, if the season be favourable, the white turnip throws out so much top that the extra space is required both to admit a sufficient supply of air and to give room for the growth of the bulb.—JOHN GREY.

† As the Society wish to know the different modes of cultivation employed by practical farmers in considerable districts, I here beg to draw

V.—The Manner of performing the Hoeing.

In considering how turnips ought to be hoed, it is necessary to bear in mind the following three points:—

1st. At what distance from each other in the rows, under their circumstances as to manure, &c., turnips in rows any given distance asunder would attain the largest size per turnip?

2nd. How far a greater number of turnips in the rows may make up for their being of smaller size?

Turnips, considered as spheres or balls, are in proportion to each other as the cubes of their diameters.

That this point may be more generally understood, I will show in figures the comparative solid contents of nine turnips, whose diameters are, 4, 5, 6, 7, 8, 9, 10, 11, and 12, respectively:—

	4	5	6	7	8	9	10	11	12
	4	5	6	7	8	9	10	11	12
	16	25	36	49	64	81	100	121	144
	4	5	6	7	8	9	10	11	12
	64	125	216	343	512	729	1000	1331	1728
Solid Contents }	33½	65½	114	179½	268	381½	523½	697	904½

Where the diameter is *doubled*, the solid contents of the turnip are increased eightfold—512, the cube of 8, being equal to 8 times 64, which is the cube of 4; and 268, the contents of the turnip, being also 8 times 33½. Where the diameter is *trebled*, the size of the turnip is increased 27 fold,—1728, the cube of 12, being equal to 27 times 64, which is the cube of 4. Thus a turnip which is 8 inches across, is equal in bulk to *eight* turnips which are only 4 inches across, and a turnip 12 inches across is equal in bulk to *twenty-seven* turnips which are 4 inches across.

3rd. At what size turnips afford the greatest nutriment to the animals which consume them in proportion to their bulk?

their attention to G. in my schedule. This gentleman lives between Brigg and Barton-on-Humber; he is acknowledged to be one of the best farmers, if not the best, in the county of Lincoln, and his name may readily be known to any one travelling that way who will inquire for him by my description. In his letter to me of February 21, 1842, accompanying that return, he says, "I have filled up your schedule according to the customary mode of turnip husbandry practised by me and most agriculturists in this neighbourhood. I dare say you will be surprised at my remark respecting drilling so near as 14 inches; but I am of opinion that, where the same quantity of manure is applied, as great a weight per acre may be produced, and they will be much better food for sheep. Still the distance is objectionable on account of not being able to use the horse-hoe."

It is well known, that white turnips degenerate in feeding qualities when they get beyond a certain size, especially if not consumed early; therefore our attention must not be devoted to size only, in growing them, although it is very desirable to attain as much bulk per acre as is consistent with good quality.

Where the young turnip plants are very thin in the rows they may easily and readily be singled by the hoe alone; but, where turnips are very thick in the rows, it is desirable, if not actually necessary, that singlers should be employed. A man, with an active boy or girl, of about ten years of age, singling after him, will do in this case quite as much work in a given time as two men, equal as hoers, where they single their own plants. I have often heard this stated by good turnip-hoers; and in proof that they believed the advantage of singlers even greater than I have stated, I have seen men take it in turn to single after each other early in the morning, before their children arrived in the field, although, from the length of a man's back, he would much rather hoe than single. A child that will attend to proper directions, may single turnips quite as well as a person fully grown; and indeed any increase of size tends to disqualify for the work. In all rows of turnips, some of the plants *from the first* take a decided lead of the others, and the difference would daily increase. Therefore the hoer must not be *too* particular about leaving the plants at regular distances; but take out those that are decidedly marked as dwarfs, even if he makes a space of two or three inches beyond what would otherwise be desirable, and for the same reason he must in some cases leave the plants nearer together, rather than go to the usual distance to leave one much inferior. The same reasoning will apply in singling, and the child should have directions accordingly. Where the hoeing is done by men, with children following them to single the plants, the hoe ought to be rather shorter than when each sets out his own. Therefore, if the average distance required is 10 inches, a hoe of about 8½ inches in length will be sufficient, and that is the common size in the district I more particularly allude to. I think that where this average distance is not adopted, a greater would be more desirable than a less space, especially for swedes. The hoe requires drawing through the plants just below the surface of the soil, with a firm and steady hand; for if the "chopping" system is followed, the work will be imperfectly done; in some places the soil will be removed too deeply, and probably the manure along with it; and in others the plants intended to be removed will be imperfectly cut, or taken off above the ground, and after a few days they will so far recover as to seriously impede the growth of those intended to be left single. The singlers should take hold

of the very best plant left by the hoer with one hand, and with the other draw out all the plants adjoining it. The holding with one hand will generally secure the choice plant intended to be left. I am quite convinced it is much the best plan to have turnips as well hoed as possible the first time over. They are never afterwards so good to set out singly at proper distances. If the land is clean, and the turnips have been well hoed once, it is of comparatively little importance whether they are "run over" again, except that the breaking of the soil about the plants makes them grow more rapidly, whilst those not properly singled, the first time of going over, soon smother each other, and then are in a worse state than ever.

I have heard, from very good authority, of turnips having cost a guinea per acre in hoeing three or four times over; and, *after all*, my informant and I thought them a much worse crop, *through bad hoeing only*, than they would have been if well hoed only once over, which they might have been for 7s. per acre. A few years ago I used to get 18-inch rows well hoed once over for 6s. per acre; but the price of labour in the district of which I am speaking has since increased at least one-sixth.* The cost of hoeing turnips is of course in proportion to the distance the rows are apart; and the manner in which the first has been done will regulate the cost of the succeeding hoeings. Of course the land must be made perfectly clear from weeds at this stage, if that has not been accomplished before.

General Observations.

Having endeavoured to describe the drill system of growing turnips, as now practised by some of the best farmers on the wolds of the East Riding of Yorkshire, I will point out some of the effects of this system as increasing the produce of the land in that district, and employing its industrious population.

Within the last forty years the wolds of Yorkshire were con-

* The prices named here for hoeing once over will no doubt be considered very high: the reasons why they were given were,—

1st. The wages of agricultural labourers are higher in that district than in most others.

2nd. The turnip-seed being sown very thickly, for the reasons already stated, the turnips were proportionably worse to hoe.

3rd. The farms being large, and at a distance from any village, the turnip-hoers lost nearly two hours daily in walking to and from their work.

4th. From being determined to have the work performed as well as possible (which I maintain will be found good policy), it was necessary to give liberal prices in order to command at all times a sufficient number of good workmen for the great extent of turnips sown.

sidered as quite unfit for the growth of wheat ; but now they grow fully as good crops of wheat per acre as the average of the kingdom. As a sample of the change in this respect, a friend of mine sold the late occupier of the farm B, mentioned in the annexed schedule, wheat for the use of his family, because that farm would not then grow wheat, or rather because it did not then grow sufficient, for the use of his family. Both the parties I allude to lived to see that farm grow wheat, 100 acres together, which was supposed by the best judges to have 5 quarters per acre. This was told me by the individual who sold the wheat, and who had afterwards seen the beautiful crops I have described. I do not say the farm grows, on an average, 5 quarters per acre, but the crops of wheat on it will generally be found decidedly above the average of England ; and all this resulted from *high* cultivation, *long* continued.

There are several farms in that district now producing excellent crops of corn, &c., which only a few years ago were rabbit-warrens ; and others, which, during the same period, have changed from sheep-walks (that is, land on which a few sheep would barely exist until two or three years of age, and then fetch a trifling price) to good corn-land, in addition to the well-known fact, of their now keeping about as many sheep as before, which are generally *sold fat* when shearlings.

It might be unbecoming in me, a party interested, so far as the credit of my native county is concerned, to put forward statements merely as my own opinion, therefore I will not only give the opinions of others, but afford my readers an opportunity of judging for themselves what the sheep of those wolds are at the present time. On the 25th September, 1839,* at Weighton fair, I heard a very intelligent Scotch gentleman, who farms extensively in the East Riding, and who is himself well known to possess an excellent breed of sheep, say that he thought it probable that there were not in the whole world 200 sheep of the same age in the possession of any other person so good as the 200 wether shearlings belonging to Mr. —, which he was pointing out. The observation was worthy of more weight as coming from one who certainly seemed to have no reason for speaking more highly of what he saw there than he really thought. It was not addressed to the owner of the sheep, nor to any of his particular friends, but in the open market. I will not say here that I thought the gentleman might be right ; but I will venture to say that, if any of my readers see the sheep shown by Mr. — of B—— B——, and Mr. — of G——, at Weighton fair,

* Market Weighton is about nine miles from Beverley, on the road to York.

they will probably find them such as would be difficult to match by 400 *of the same age in the possession of any other two individuals*. I know that the average price for the last four years at which one of these parties has sold his 200 wethers yearly (they then being about 17 months old) has exceeded 65s. per head, and that they were supposed to weigh from 30 to 33 lbs. per quarter each. I am aware that much confidence is not placed in supposed weights, therefore I name what was under the average price.

Another consequence of the rapid improvement in agriculture in that district is, the comparatively high price of labour. I think I am justified in saying, there is no other district in Britain where the wages of good agricultural labourers are so high as in the East Riding of Yorkshire. Many men are now employed there who have come from other parts of the kingdom; but at first they have to take lower wages; simply because they are scarcely ever worth so much as those trained there. Large farms are common in the East Riding, and they afford the occupier opportunity of selecting men for each particular kind of work, according to their peculiar qualifications for it. Thus on such farms each kind of work may generally be seen executed in a superior manner. By having good examples generally before them, the men are more likely to acquire a desire to excel in some particular part of their work; and, as soon as their master has observed a decided superiority, he will take care to afford all the opportunities he can for practising. I have been told by persons in different parts of the country, that they ridge at 27 inches apart, merely because they can then use the horse-hoe. To such I would only further say, I have seen hundreds of acres of turnips drilled on level *as straight and at as regular a distance as I ever saw cabbage rows in gardens at Fulham*, and in consequence of that straightness as well horse-hoed or scuffled as possible at any distance, although only 18 inches asunder.* Therefore they must not suppose that, because it is difficult, and they have not yet succeeded, none can accomplish it. Those who can lead a drill-horse well are almost sure to be good ploughmen, if they have had practice; but it by no means follows that excellent ploughmen could, if they chose, lead a drill-horse straight. The man who can walk straight with a plough to support him sometimes fails completely when he makes the attempt, not only without such assistance but with the drawback of having to lead a horse at a certain distance from him.

* I know several cases in which the horse walks in the 14-inch rows without leading, and without doing damage.—G. KIMBERLEY.

To lead a drill-horse straight on level land, with a common drill, requires a person with a firm, steady step, and who, of course, can walk perfectly straight. He must also keep his attention constantly on his work, and his horse at a regular distance from him. For this there is quite as great a difference in horses as in men. I have known instances where the drill-horse could not be relieved at his work by another without spoiling the appearance of the drilling, although there were upwards of thirty good plough-horses to choose from.

In gaining the experience on which the foregoing observations are founded, my maxims were,—“Observe thy neighbour’s practice and the effects that follow it, whether he has the reputation of being clever or not. Above all, be cautious not to pin thy faith too closely to those who have the reputation of best knowing their business. Pay the utmost attention to what they do or recommend, that thou mayest *SELECT only such* of their modes as are suitable to thine own circumstances.”

11, Great George Street, Westminster.



SCHEDULE.

[illegible]

SCHEDULE.

sowed for ing.	Quantity of Seed per acre.		Kind of Manure.		
	Swedes.	White Turnips.	Swedes.	White Turnips.	
White Turnips.	Lbs.	Lbs.			
Last week in May to the 21st of June.	4 to 5	3 to 4	Bones, or farm-yard manure and bones.	Bones.	These two parties occupy similar land, each having about an equal proportion to the other of thin and deep soil. They sow part of the latter with rape, to be eaten off by sheep.
Last week in May to the 21st of June.	3	3	Farm-yard manure and bones.	Bones.	
From last week in May to 15th of June.	3	3	Farm-yard manure and bones.	Bones.	
Last week in May, and first week in June.	2	2	Farm-yard manure and bones.	Bones.	
Second week in June.	4 to 6	4 to 6	Farm-yard manure.	Farm-yard manure.	More stock is kept on this farm in proportion to its extent than on any other I know.
	2 or 2½		Farm-yard manure with bones and ashes.		This gentleman says he moistens the turnip-seed by rubbing it through the hands with <i>fish-oil</i> , afterwards drying it in the sun, or at a distance from the fire, which promotes early vegetation, and since adopting this plan never suffered from the fly. After hoeing and scuffling two or three times over, banks the turnips in the "carrs."
Second or third week in June.		2 or 2½		Bones and ashes.	
From the 1st to the 21st of June.	3	2½	Farm-yard manure, bones, and ashes.	Farm-yard manure, bones, and ashes.	Formerly drilled white turnips 14 inches apart, with same quantities of manure, and got quite as good crops, but prefers 16 inches, as being better to scuffle and clean.
Third week in June.	4 to 5	4	Farm-yard manure.	Farm-yard manure.	
Early in July; if heavy and cold land, earlier. If light and hot, not so early.	3	3			
Middle of July.	3	3	Farm-yard manure.	Farm-yard manure.	Mixes sulphur with turnip-seed (about 1 lb. to a peck of seed) "to pre- vent jacks or flies." His land is generally low, near the River Stour, and on gravel. If sown earlier than the times stated, the turnips become mildewed.

VI.—*On Horse-hoeing Flat-drilled Turnips.*

By PH. PUSEY, M.P.

HAVING lately ventured to express an opinion, founded on the experience of South-country farmers, that the system of growing turnips upon raised ridges, however well adapted to Scotland and to the North of England, could not be universally used in the South, I am glad to find that view strengthened by the paper of Mr. Almack, which enters indeed so fully into the whole subject, that I should not now have added one word, but from the desire of calling attention to an implement which removes one great disadvantage of flat-drilling, I mean the want of a horse-hoe, and may, I hope, enable us to remove the chief blot from South-country farming, our broad-cast fields of straggling turnips.

Mr. Almack intimates that, since the dry summer of 1826, the ridging of turnips has diminished in Yorkshire, at least upon shallow soils. I should rather have anticipated that the climate of Yorkshire would have produced a conformity of practice with Scotland; but it must be remembered that, besides the difference of heat and cold arising from situation towards the north or the south, there is a very great difference in the quantity of rain which falls on the eastern or western coast of this island. In Cumberland, I believe, the average quantity of water falling in rain doubles the general average of England. Lancashire again is a rainy county, and hence, though it is in the same latitude with Yorkshire, the ridge-system I believe answers there. It is not, however, the mere quantity of rain that may assist the growth of the turnip on our western coast. Even though the amount of water which falls in the year be the same, it rains there, I believe, oftener; and the same quantity of water being thus distributed more equally, preserves the ground from being thoroughly parched. There is also, I believe, more invisible vapour dissolved in the air towards the west coast; and besides these differences, the sky, even on fine days, is more covered with a general canopy of light cloud, which alone would preserve the turnip from the mildew produced even by one day of glaring sunshine, when its root is at all dry. But at all events there is now no doubt that in many parts of England the turnips, if drilled at all, should be drilled flat; at present they are sown broadcast in many of the southern counties, and of course cannot be horse-hoed: now the expense of hand-hoeing turnips is a heavy item; it cannot be done less than twice, which at 5s. for each hoeing, comes to 10s. the acre; sometimes it must be done three times, which may cost 14s. the acre: and besides the expense of hand-hoeing turnips there is often a difficulty in procuring workmen at the right time, particularly if the harvest be early. Last July I remember seeing twenty men

hoeing in a turnip-field, while the hue of the neighbouring wheat invited the reaper. In the following week the sickle and scythe were busy in the corn, but I saw turnips spoiled because the time of thinning them had gone by. It was clear, therefore, that turnips sown flat ought, if possible, to be horse-hoed: and soon after, in visiting some farms of Lord Yarborough's, near the Humber, I found the turnips flat-drilled, and a horse-hoe commonly used on them. I found too the expected saving. The horse-hoe is of the same width with the drill, so that all the rows passed through by it have been sown at once, and are therefore true to each other: it cleans about six rows at a time, stirring the ground close up to each row. One horse, I found, is able to scuffle 10 acres in a day. Soon afterwards a man and child hand-hoe the rows, setting out the plants to the right distance, for about 5s. an acre. Generally no more hand-hoeing is required, repeated horse-hoeing is sufficient. Here then is a saving of 4s. or 5s. per acre; and saving is the most certain profit. The turnips are better too for the more frequent stirring they receive from the horse-hoe. I will not describe the implement used in Lincolnshire, because a more perfect one has been invented by Messrs. Garrett, which has received the Society's prizes, both at Liverpool and at Bristol. As any mere trials, however, are less satisfactory than actual work on a farm, I have obtained an account of its working from practical authority, and the following statement of its performance will, I trust, be satisfactory. Several farmers, I know, regard this horse-hoe as one of the best implements lately invented. On an arable farm of 400 acres, the price, which varies from 19*l.* to 13*l.* 10*s.*, might be saved by its use, I should think, in the first season:—

To Mr. R. Garrett, Leiston Works, Suffolk.

Dear Sir,—Knowing that there must be considerable difficulty in a manufacturer's introducing a new agricultural implement, however good, into general use without testimonials from those who have tried them, I am desirous of stating to you my opinion of your patent horse-hoe, at far as my experience will allow me. I first used it in hoeing beans, drilled at intervals of 12 inches on 10 furrows, or 7 feet 6 inches stretches. The land at the time was so dry and hard, I was afraid the hoes would break, or not cut through the crust. However, I can say the work was well done; and that, without the horse-shoe, the *hand*-hoes could not have been used so soon, which followed to cut the weeds in the rows. I found no injury done by the hoe cutting the plants, as some persons might apprehend; but much of the correctness of the work of the horse-hoe must of course depend on the drilling being well executed. I think it advantageous to the hoeing that a drill, covering the whole stretch should be used, as the hoe covering the same quantity of land is more likely to fit the work.

I had considerable experience of the efficiency of the horse-hoe in cleansing turnips, and I can say that the work was done to the admiration

of several of my agricultural friends who saw it at work. The dispatch with which the work is done is very important to the farmer, and greatly in favour of the hoe, as advantage can be taken of dry and suitable weather to run over the whole crop in as many days with this implement as weeks would be occupied with hand-hoes only. Of course workmen follow the horse-hoe to single the plants and cut the weeds in the rows, but their work is much better, and more quickly executed, from the horse-hoe having preceded them, and the land is brought into a much better state of tilth. My turnip crop was much cleaner last season than usual, and cost less per acre, too; and I cannot but attribute the cleanliness of the crop, and saving of expense, to the use of your horse-hoe.

As to hoeing wheat with it, I cannot make any report to you, as my wheat crop is still on 12 furrows' work.* I can hardly doubt it will answer, as the depth and width of cutting are so easily regulated, and provided the drilling is properly executed.

Now that you have added side-hoes to my implement, I shall be able to cut and clean the furrows at the same time with the stetches, which I had previously to do with a separate furrow-hoe.

I ought to mention that my farm is rather a severe trial for the horse-hoe, as I had both heavy and light and stony land, as well as steep hangs or hills.

Yours, very obediently,

THOMAS LOMBE TAYLOR.

*Starston Place, near Harleston,
February 25, 1843.*

Account of a New Horse-Hoe, by R. Garrett and Son, Leiston Works, Saxmundham, Suffolk.

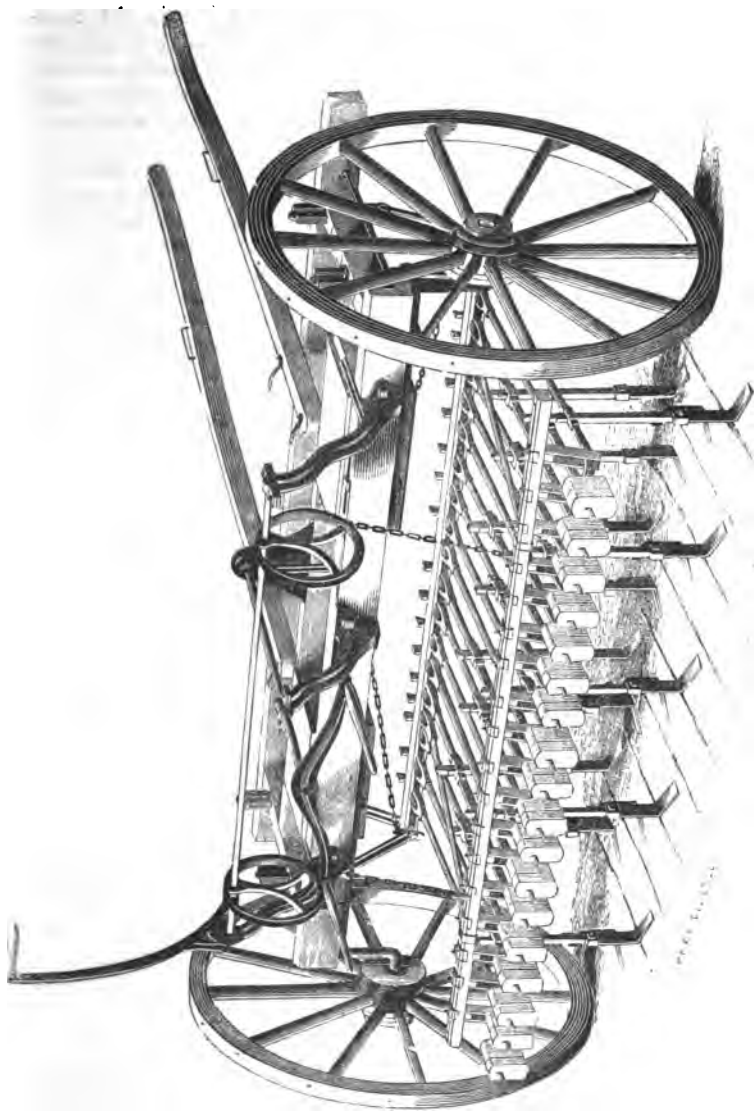
This implement is so complete in itself as to be fully suited to all methods of drill cultivation, whether broad, stetch, or ridge ploughing; and is adapted to hoeing corn of all sorts, as well as roots. The peculiar advantages of this implement are as follows:—

It may be increased or diminished in size to suit all lands or methods of planting, the axletree being moveable at both ends, either wheels may be expanded or contracted, so as always to be kept between the rows of plants.

The shafts are readily altered, and put to any part of the frame, so that the horses may either walk in the furrow, or in any direction to avoid injury to the crop.

Each hoe works on a lever independent of the others, so that no part of the surface to be cut, however uneven, can escape: and, in order to accommodate this implement for the consolidated earth of the wheat crop, and also the more loosened top of spring corn, roots, &c., the hoes are pressed in by different weights being hung upon the ends of each lever, and adjusted by keys or chains to prevent them going beyond the proper depth. What has hitherto been an insuperable objection to the general use of the horse-hoe is overruled in this by the novel and

* Many farmers have used this horse-hoe for wheat with success.



easy method of steering, so that the hoes may be guided to the greatest nicety, if common caution be used, doing every execution among the weeds without injury to the crop.

This implement is so constructed that the hoes may be set to any width from 7 inches to any wider space: for the purpose of hoeing all

kinds of corn the inverted hoes *only* are preferred; but for the root-crops, where the rows of plants are wider (say 16 inches or more), an extra hoe, of a semicircular form, is placed on a separate lever, working between and in advance of the two inverted hoes, for the more effectually cutting all the land, however uneven the surface, by the three separate hoes working independently of each other between the rows.

The hoes are of peculiar improved manufacture, the blades being of steel, and made separate, and attached to a socket handle in a simple and easy, yet effectual, manner, so that any husbandman may replace them; and being manufactured by the patentees at an exceedingly low price, no difficulty can arise in replacing those parts subject to wear.

In order to set the hoes in a proper cutting position, for either flat or stretch ploughing, and so as thoroughly to cut either hard or soft ground, the levers are put into a more or less oblique position, causing the cutting edges of the hoes to be more or less inclining downwards, by raising or lowering the jointed irons to which the forward ends of the levers are suspended and swing, which is done by merely moving the pin, which rests upon the frame, into different holes.

VII.—*On the Advantages of Ploughing-up Down-Land.*

By THOMAS WALKDEN.

To Philip Pusey, Esq., M.P.

SIR.—In reply to your inquiry whether the bringing into cultivation the down pasture of the south-west of England would not be a great means of improving the established comfort of the labourer by increasing the means of employment, I am desirous of bearing testimony to the practicability of carrying this much-needed measure into execution.

I have witnessed large tracts of forest, heath, and wold land, in different counties, brought into a very high state of cultivation under much greater disadvantages than the present state of the downs: but the mode adopted has been decidedly opposite—the occupiers enriching it with green crops and manures, instead of exhausting it with successive corn-crops, as has invariably been pursued in breaking up down-pasture.

The farm I now occupy, on the lightest part of Salisbury Plain, was taken in 1832, on a ten years' lease, at 24s. per acre, rent and tithe. The first crop was wheat, which, I believe, exceeded 4 quarters per acre. The next oats, which I ascertained to be nearly 8 quarters per acre. Then turnips, without manure, except 1 quarter per acre of bone-dust for the swedes. The occupier then left it, declaring that the land was exhausted, and would ruin any one to work out the lease. I ventured to undertake the farm for the remaining term; and for the first three

years I certainly had the worst crops imaginable: wheat and barley, little more than the seed again; oats, about 4 quarters per acre, under 30 lbs. per bushel; grass seeds would not grow, the land was so light—indeed, such clouds of dust frequently blew from the land, that sheep could not pasture near it. The improving state of the farm, from the turnip system and artificial grasses, fed green, is now apparent: 7 quarters per acre of oats are easily attained, and of good quality. The present rent and tithe (though too high for the times) is 18s. per acre—at least four times its original value.

I beg to give you another instance of down-land, of a stronger and better description, being brought into the Northern system of cultivation by Mr. Brough, of Shaw Farm, near Marlborough. He has boned his land to a very considerable extent; and his turnips, thus managed, have invariably been a great crop. It is his opinion, that were the system of two corn-crops in succession, and of mowing the seeds for hay instead of pasturing with sheep, done away with, the land would become more certain for turnips, particularly swedes, than in the north. He has also grown linseed with success; for which he considers the lightest of the Downs particularly adapted. He thus obtains a substitute for oil-cake, the carriage on which from London renders it very dear. Linseed is sown, instead of barley or oats, in the Spring. He has brought into cultivation the whole of his down-pasture, and is enabled, by artificial grasses, to keep more sheep in summer, and much better than in its original state. But his greatest advantage is in the winter: a good turnip system, in lieu of hay, enabling him to provide food for many more sheep at a far less cost, as well as keeping them in a much higher state of condition.* In short, the farm will bear comparison with the rich land of the neighbourhood, considered of twice the value.

I am fully aware that there are many obstacles to be surmounted before the inestimable plan of cultivating the downs can become general. The farmer who has had a sufficient tract of pasture-land to manure other land, not only without cost, but at a considerable profit, will not consider his position benefited by losing the sheep-dung from the down; and that, as a substitute, he must expend many hundreds per annum in artificial manures,

* The reason why those who have been accustomed to feed their sheep chiefly on hay consider that food indispensable is, that on turnips alone sheep cannot fast nor travel, but must have a constant supply day and night: a shepherd accustomed to dry food would of course be ignorant of the management of sheep fed on turnips only; without plenty, at all times, they would do much worse than on hay, and in all probability the loss would be great; but if the art of keeping sheep *well* on turnips without dry food cannot be acquired, let corn in the straw be cut into chaff, and not sacrifice the best grass of the farm.—TH. WALKDEN.

and oil-cake or corn, for cattle to convert the straw into rich manure—the land-agent will be backward in recommending the landlord to adopt any changes which will cause him more trouble*—the landlord will fear the outlay of money for farm-buildings, lest, after all, the land should be exhausted as it has hitherto invariably been: but I have not yet seen that any of these three classes have any advantage over similar classes in more improved districts; and the poverty of the labourer, arising from a bad system of farming, is lamentable to contemplate: they only who have been masters of well-paid labourers, as well as of men who only receive the miserable pittance of 7s. or 8s. per week,† can fully appreciate the advantages to be derived by making work as plentiful here as in other parts of the kingdom. The injuriousness of a system that creates so little labour is most apparent by a comparison of the different states of the labourer in the north and the south of England. In every respect the southern labourer has the dis-

* No land-agent would, I hope, be influenced by the motive here stated; but his practical intelligence and his duty to his employer may well render him cautious in advising the breakage-up of old sward, for the speculative advantage to the landlord of obtaining an increase of rent by an outlay of capital which may never be repaid.

I have been for many years well acquainted with the downs of Surrey, which, previous to the late war, were almost wholly under turf; but, during the prevalence of high prices for farm produce, a great portion of the land was broken up, and afterwards laid down again to pasture when the prices fell. I have ridden over various parts of the downs very recently, and in many instances where the soil has been full twenty years thus relaid to grass, I can affirm that the sward is not now of half the value that it was originally.

Lord Portman's plan (as stated in this Journal) speaks nothing to the purpose of breaking up down-pasture; for it was tried upon land not worth 2s. 6d. an acre, and although that land will now doubtless bear a fair rent, yet it, in fifteen years, has left no profit worth speaking of, and if the charge of a bailiff were put down, it would have left a loss. It may, indeed, be questioned whether it is even now so valuable as if it were in *old* down pasture? But too much praise cannot be bestowed on the beneficent motive by which his Lordship was actuated, and the liberal manner in which he carried it into effect.—FRENCH BURKE.

I think we must be cautious in breaking up very thin down-land, because, if it should not answer, and particularly if the land be overcropped, there will be difficulty in recovering the turf. But where down-land can be safely broken up, and is likely to be well-treated afterwards even without any extraordinary outlay for manure, I think landlords would do well to encourage this improvement, chiefly with a view to increased employment for the agricultural labourer.—PH. PUSEY.

† From this fact, the Northern farmer erroneously supposes that he is in every respect superior, as an agriculturist, to the Southern, whereas in no part of England is good strong land better farmed than in Wiltshire, particularly for wheat; and all farming operations (except the slow and expensive manner in which horse labour is performed) are conducted in a very superior manner.—TH. WALKDEN.

advantage : most of his necessary wants are dearer, land is generally let to him at a higher rate than to the farmer, his house often comfortless and confined, even to indecency, his wages barely sufficient to provide his family with food.

The poor labourers by whom I am now surrounded on Salisbury Plain consume very much more flour than my late labourers at Saxby, near Barton-on-Humber, Lincolnshire, because the latter were able to purchase a larger quantity of animal food. 1 pound of meat and 2 pounds of potatoes constitute a desirable substitute for 3 pounds of bread, and ought to be the daily portion, in addition to flour, of every hard-working man.

The alternate system makes these comforts attainable. The successive corn-growing plan on poor soils, as practised in so great a portion of the kingdom, invariably reduces the rate of wages below what it ought to be, when compared with the price of food.

There need surely be no reason why the labourer in the south may not be as comfortable as his fellow-labourer in the north. The fact that he is not so is beyond controversy ; and the very opposite systems of the two divisions of the kingdom will account for the difference, so striking, in their condition. The generally adopted system of farming light soils in the best-cultivated districts is the following :—turnips or rape ; barley or oats ; grass-seeds fed green two years : afterwards wheat. Some years ago, many were of opinion that the four-course shift was preferable to the five ; but time has fully proved the many disadvantages of the former system.

Many are the sorts of grass that may be sown with advantage : white clover stands highest in estimation, but care must be taken that the land is not exhausted by any one sort of seed. Two-fifths of the farm fed green will keep sufficient stock to ensure a good crop of wheat. A well-managed turnip crop will secure a high state of cultivation during the course of five years. The land will keep improving ; and from the whole a reasonable profit may be expected.

It is the want of sufficient moisture, in many parts of the kingdom, that causes the crop of turnips to be more uncertain than in those districts where the atmosphere is more humid, a disadvantage which the decayed turf of the seeds tends greatly to remove. Experience, in different counties, has convinced me (and the wise measures of the Royal Agricultural Society to concentrate knowledge will doubtless confirm the fact) that as any light dry district is farmed on the alternate system, or on that of successive corn-crops, the country is prosperous or the reverse, wages high or low : this, I think, is indisputable. In those counties where corn is grown after corn on light poor soils, the common price for mowing, getting together, and raking an acre of barley or oats, is only

2s. 6d.; nor is any part of the harvest wages so profitable for the labourer as this, owing to the general lightness of the crop. The turnip-crop not only creates a great deal more labour, but it affords so much employment in winter. In no part of the country are labourers worse paid than in the south-west of England; and nowhere are they better paid and more comfortable than in Yorkshire, Lincolnshire, Nottingham, and, I believe, some parts of Norfolk. My knowledge of the mode of cultivation in these counties, from having farmed twenty-six years on the north wolds of Lincolnshire, and frequently visiting my friends and relations, who were agriculturists in Yorkshire and Nottinghamshire, and my present acquaintance with the south-west of England, by farming 400 acres of the lightest part of Salisbury Plain, convinces me that the lamentable state of the labourers in the latter district is owing to the inferiority of the system of farming light land, particularly by exhausting it when first brought into cultivation. As there are extensive tracts of land yet untilled which might be made useful turnip-land, and ought not therefore to remain in their present unproductive state, it may be important to draw the attention of the Society to the extraordinary difference of system that has long been, and now is followed in first bringing poor soils into cultivation in the south, and that which has been practised with such beneficial effects in other counties. In a considerable part of the south-west of England, however poor and light the soil, it is first sown with wheat—by this means made lighter when it should be made firmer: it is next sown with barley or oats; thus made poorer instead of richer: it is then sown with swedes, and if any manure is applied, this consists only of a few ashes, or at most one quarter of bone-dust per acre. What would our predecessors have thought of this pitiful dressing who, forty years ago, never put on less than 60 bushels per acre? In feeding off the swedes, the sheep are frequently taken away at night to manure some more valued land. After swedes, barley or oats are sown, as it may be supposed the land is, by this time, too poor and light for any artificial grasses, with the single exception of ryegrass, which moreover is not fed off green by sheep, but cut for seed. Other rounds of miserable crops follow, substituting rye for wheat, oats for barley, but nothing is done to improve the land: almost everything indeed that the land produces is taken away to enrich better ground, until it is no longer capable of remunerating the farmer for the expense of cultivation, when it is left in a worse state than when it was first broken up. What a contrast to this ruinous system was the plan pursued in first bringing into cultivation the once poor sandy forests, the barren heaths, the rabbit-warrens, and the almost valueless wolds of other counties!

They were first sown with rape or turnips, fed off on the land; next oats, then turnips again, manured with well-made farm-yard dung, boned, chalked, or clayed until the barren wilderness soon became, and still continues, the fruitful field; affording remuneration to the occupier, comfort to the labourer, and pouring out a blessing upon the country. It is too generally taken for granted that land in an impoverished or uncultivated state is *inferior* to that which has been well attended to, when the only real difference consists, not in the quality of the soil, but in the mode of treatment. Had the improvements in agriculture, which have so long been carried on with success in Northumberland, Yorkshire, Lincolnshire, Nottinghamshire, and Norfolk, been adopted on the poor soils in the South, the result, in all probability, would have been the same. It is quite clear to me that if no more capital had been expended on the soil of a great part of the more northern counties than has been laid out on the southern, and if that soil had been as hard cropped, the former district would have been as far inferior as it is now superior. A great portion of the land of the south downs and of the north wolds are, in many respects, very similar: both are naturally of a light dry weak soil, of little value before cultivation, and exceedingly inferior to many others even when cultivated. They have each a substratum of excellent chalk, which contains the foundation of future improvements, and without the application of which all attempts at *permanent* improvement are vain. The two countries are contiguous alike to good grass-lands, the cattle from which, fed judiciously while consuming the straw, afford the advantage of excellent manure. There is in each district good inland navigation communicating with sea-ports, affording an opportunity of obtaining various artificial manures from every place. Two districts, thus similar in their nature and resources, but so opposite in their mode of cultivation for the last half century, prove the many and great advantages of a good system of husbandry and the much-to-be-regretted results of a bad one. The one country continues to increase in fertility, the other still remains in a state of comparative sterility. The northern district, from the *port of Hull alone*, encourages commerce to a large extent. The imports for 1841 amounted to—

Linseed	120,865 quarters.
Rapeseed	77,380 „
Oil-cake	8,346 tons.
Rape-cake	5,255 „
Bones	25,908 „
Total value	£ 900,000.

The southern district makes very little use of foreign productions for the improvement of its light poor soils; indeed it is

capable of promoting in but a very small degree the *home* trade of the kingdom, the labourers' wages being barely sufficient to provide them with food. Whereas, under a well-conducted alternate system of agriculture, there always exists a well-paid and well-clad population, which cannot fail to cause a mutual reciprocity of good feeling between the agriculturists and manufacturers.

I well know that there are many farmers who take care that their labourers are made more comfortable, by letting them land, and by employing, from charitable motives, their children. Highly commendable as this is in these respectable individuals, yet it does not do away the consequences of a bad system. The young unmarried men have no means of saving anything for a future day. Nothing can afford an effectual remedy but the adoption of a system of cropping light soils which will produce more labour. So long as the only attention required for sheep during the greater part of the winter is merely feeding them with hay, so long as such an immense quantity of inferior down-pasture is kept out of cultivation in order to uphold a system of successive corn-crops on other land, wages must remain low, the production of the soil be far less than its capabilities, and the manufacturers receive comparatively but little custom from the agriculturists of such districts.

Next in importance to a good system of cropping is the making of good manure: if made by cattle, eating straw only, it will be of little value for light soils. Oil-cake is so much dearer than corn that the latter, which is always attainable, is frequently preferable. The best method of using it is to cut peas, barley, or oats in the straw into chaff. One ton of corn per acre, and about 2 tons of straw will amount to a crop, consisting of about 15 sacks of oats, 11 of barley, and 9 of peas. The price of abundance of spring-corn is now 7*l.* per ton: two-thirds of straw being added will make valuable fodder at 2*l.* 6*s.* 8*d.* per ton, or $\frac{1}{4}$ *d.* per lb. 12 lbs. given daily to each beast for twenty weeks will cost 35*s.*; to this add 14 lbs. of turnips, the value of which is $\frac{1}{2}$ *d.* at 6*s.* 8*d.* per ton, reckoning an acre of 12 tons weight at 4*l.* According to this calculation, the extra cost of keeping a young beast in good holding condition for twenty weeks will be 40*s.* 10*d.* The smallest quantity of oil-cake I have known given to beasts, calves excepted, is 3 lbs. daily, amounting in the same period (at 12*l.* per ton, a common price) to 43*s.* 6*d.* It is hardly necessary to state that the above quantity of corn must be more advantageous than the small portion of oil-cake usually given; yet to give the oil-cake would be infinitely better than to feed the beasts with straw only.

I give my opinion with perfect confidence on the greatly increased value of the manure from keeping growing cattle well,

having farmed Saxby Wold Farm, conjointly with my father, from 1812 to 1836, where we never wintered so few as a hundred beasts.

Nothing could exceed the extreme poverty of the light wold land of this farm when originally taken by us. The first round of 60 bushels per acre of rough bones had but little effect: 3 quarters of barley per acre was the miserable produce, even after a good crop of turnips, fed on the land.

A regular supply of plenty of well-made farm-yard dung, in addition to bones and chalking, made the lightest of the land, by adhering to the five-course system recommended in the foregoing remarks, cheaper at 30*s.* per acre (the rent in 1836) than it was at 10*s.* per acre (the rent in 1812).

The same success, in a greater or less degree, has attended the adoption of this mode of cultivation throughout various *large districts* in Lincolnshire, Nottinghamshire, and Yorkshire. To cut corn and straw together into chaff, unless the price of corn be high, will be found equally beneficial for sheep. Although the turnip crop ought to be good enough to leave sufficient dung from the sheep feeding off it, without requiring the addition of any other food to enrich the land, yet the advantage is great if substituting the cut corn and straw enables the farmer to draw turnips for the cattle in the fold-yards; for instance, 1 lb. per day of cut corn and straw, at $\frac{1}{4}$ *d.* per lb. or 2*l.* 6*s.* 8*d.* per ton, for each sheep on turnips, will be but 3*s.* 6*d.* from Michaelmas to Lady-day, for which the sheep will leave a profit, the market price of the corn will be obtained at home at less expense than by threshing and sending to market, and a large supply of excellent manure will be procured for nothing. It is well known that hay is dear food for sheep, and the manure from it inferior. To mow the first year's seeds deprives the farmer of an opportunity of consuming it when it would yield a profit and enrich the land: when converted into hay it exhausts the land, lessens very considerably the quantity of food, and deteriorates the quality in a very great degree. To keep the greatest quantity of stock *profitably*, both winter and summer, should be the first object of every occupier of light land. Additional corn crops may make a greater return for a short period, but *eventually* will not reach the average profit of the system of cultivation which I have recommended; while to improve the condition of such land by such means would be in direct opposition to established facts.

I am not, however, an advocate for a multiplicity of green crops in the same year; they cannot be procured so cheap, or benefit the land so much, as a regular winter fallow for turnips, mangold-wurzel, or cabbages, if the land be indeed good enough for the two latter. For example, rye costs 15*s.* per acre for seed alone,

ploughing and harrowing, 12s.; the produce early in April will probably not exceed a ton per acre, after which period seeds are preferable.

An additional 27s. expended in bone manure for swedes would produce far more weight of better food, and at much less cost.

Vetches, too, are a very dear green crop, and often throw the land out of condition. Rape may be obtained early enough to feed before the seeds begin to fail: thus the land gets the advantage of the winter fallow, which all light land requires to make it retain moisture in the summer; and it gives plenty of time in the spring to clean the land. Whatever rape is fed off in July may be sown again with Scotch yellow turnips, and will produce a good crop for the spring. This is the only extra crop that I have ever found beneficial.

In conclusion, I would observe that the welfare of the population at large must rise or fall with the adoption or rejection of the best system of cultivation.

*Rushall Down Farm, Salisbury Plain, Devizes,
February 22nd, 1843.*

VIII.—*Account of Shepherd's Corner Farm, in Dorsetshire.*

By LORD PORTMAN.

IN compliance with the wish which has been expressed to me, I send a statement in detail of my operations on a portion of land which I have brought into cultivation. I hope that it may afford some useful information to landlords and tenants; for although it may alarm some tenants, it may show some landlords the expense of improving land and the length of time requisite to remunerate the tenant who wishes to deal fairly by the land. The history of the undertaking is shortly as follows:—The pressure on the farmers and labourers in this neighbourhood consequent on the panic of 1826, induced me to endeavour to lessen the suffering of the labourers and to check the increase of the poor-rates by devising a scheme for cultivating by spade-husbandry a portion of land of about 200 acres, known by the name of Durweston Common, the habitation of foxes and rabbits, which was producing furze, fern, and a scanty portion of sheep-feed, giving a rent of 2s. 6d. per acre. The tenant having declined to perform the work on the terms proposed by me, I took the land into my own hands; I divided field No. 1 into a number

of squares of equal size, according to a plan given to my foreman, and affixed a price to be paid for digging each square, payable only when each was finished, allowing labourers from any parish in the magisterial division of Blandford to come and go as they pleased, and to finish the square by themselves or by deputies: at times I had above 100 men at work, at times not more than 5, according to the demand for labour in the division. I followed up this system until the five fields were dug; the sixth field was treated differently, as the pressure on the labourers had passed away. I built cottages, a barn, sheds, sufficient for the occupation of that land when attached to another farm, made a pond, planted quick-fences, and formed a road as each became requisite. I occupied the old field No. 7 to facilitate my scheme. The greatest difficulty with which I have had to contend has been the repeated failure of the turnip crop* and the consequent impossibility of giving the land as much of the benefit of the treading and folding of sheep as I could have wished. The crops which have flourished best have been grasses of any kind, vetches, oats, and potatoes. The quantity of wheat has been abundant, but the quality rough. I have managed this farm quite distinctly from my home farm, excepting so far as sending sheep therefrom as occasion required, to consume the crops and to fold the land on the new farm; and I must mention that but for the facility of moving the sheep from time to time to the home farm, no regular stock could have been kept on the new land. I have endeavoured to manage the land, as far as possible, without the use of means which could not be accessible to a renting farmer, and I have separated as carefully as I could in the accounts, the expenses which I incurred as owner and as occupier. The statements sent herewith are extracted from the books kept specially for the management of this land. I must observe that on that part of the farm where the surface-soil was not deeply buried, the crops were least good for several years, but now they are equal to those on the rest of the land. Exposure to the air and the largest application of chalk were absolutely essential to fertilize the new surface-soil; but the gradual intermixture of the old and new surface-soil by a deepening of the ploughing and by the operations of nature have rendered it productive. Field No. 6 shows the system which has paid the best,† but the difference of cost between

* Mr. Walkden informs me that a gentleman at Elston, who farms his own estate largely, lost his turnips after subsoiling down-land.—PH. PUSEY.

† This field was pared and burnt, ploughed without digging, and the first crop was not corn, but turnips. It appears to have produced very good crops from the outset, without any expense beyond that of common farming.—PH. PUSEY.

the system there applied and the plans adopted in the other fields, must be in great part set down to the want of experience in similar works, and specially to the expense of digging, which my desire to relieve the wants of the poor led me to adopt. If all this land had been treated as No. 6 was managed, a tenant might have paid a rent and received a fair profit, but the labourer would not have received the same amount of benefit that was conferred upon him; and in all similar operations proposed to be carried on by a tenant this preliminary question must be settled: "Is it the object of the work to employ and benefit the labourers, and ultimately the occupier and owner; or is it intended to look chiefly to the profits of the owner and occupier?" and according to the reply must the terms be adjusted. In the progress of the improvement I have been obliged to try various modes of cultivation, which now appear to have been wrong and to have lessened my profit as a farmer, but they were adopted as safeguards against greater loss. I have occupied the land throughout a period of great alternation in prices of farm produce and of great variety of seasons, and I have experienced the losses attendant on the injuries of insects, rabbits, and of various accidental circumstances. I purpose letting the land at Michaelmas next; and after estimating the crops which will be mine before that time, according to the present prospect, and looking at the balance of the account up to Michaelmas, 1842, I am satisfied that as a tenant I have incurred no loss, though I have made no adequate profit; but as a landlord I have made a farm of the value of the surrounding arable lands out of a comparative waste, at no absolute loss to myself, although, at the time of the commencement and at periods during the progress of the work, my neighbours, who watched my work as well as myself, who regulated the proceeding, regarded the undertaking as likely to be a failure as a farming speculation, and therefore only good for the labourers who lived by the employment. My experience, during the fifteen years which this work has occupied, of the difficulties and expenses which attend the improvement of uncultivated land, has satisfied me that no tenant could have, in justice to himself, undertaken such a work on the terms which a surveyor would have offered on the usual calculations; and I am of opinion that before a landlord urges or advises his tenant "to cultivate and improve," he should give to the tenant a firm tenure by lease for a lengthened term, and that the most sure mode of doing justice to both parties at the end of such term would be to ascertain and enter in the lease the average produce of the land at the time of entry, so that, at the expiration of the term, he may be able, having compared the difference in the productive powers of the land at the commencement and the

end of the term, to give to the old tenant the due reward for the improvements he may have made. I think the landlord and tenant should divide the increased value when settling their future bargain.

Bryanston, Feb. 25th, 1843.

Were landlords to adopt this mode of employing money, they would not only confer an inestimable benefit to society by the employment of the destitute poor, but the improvement of their property would amply repay the expenditure: as witness the account of Lord Hatherton's estate in Staffordshire (as detailed in vol. ii., No. xxv., of this Journal). It is true that men of large fortune have frequently parliamentary duties and other occupations to perform, which prevent them from expending their time on such pursuits; but they can never be at a loss to procure an intelligent land-agent, who should be resident on the property, and without any other occupation than its management.—FRENCH BURKE.

SHEPHERD'S CORNER FARM DURWESTON.

The whole of this land is on the chalk, and at a high elevation above the sea.

The fields 1, 2, 3 are of a clayey nature with some flints; the soil is of a reddish colour, and called by the surveyors "*sour land*." The fields 4, 5, 6 are also on the chalk, but less clayey, and covered with a great quantity of flint.

Field No. 1.—South Free Down—36 acres, 2 roods, 22 perches.

1826-7. Digged to the depth of 9 inches; surface-soil buried.

1827. Sown with oats; seed 6 bush. per acre; crop about 26 bush. an acre.

1828. Western half left with oats self-sown; folded over by sheep last winter; the oats a poor crop, 16 bush. per acre; much infested with fern, &c. The eastern half sown with common and swedish turnips; manure about 11 loads of dung per acre; crop of swedes pretty good; of common turnip very light.

1829. The western half uncultivated (the west and east treated differently, to ascertain the best mode of applying the chalk): the eastern half sown with white oats; seed 6 bush. per acre; crop 32 bush. per acre.

1830. Chalked; chalk carried out by donkey and in wheelbarrows; sown with common turnip-seed, 3 lbs. per acre, 28 acres; a pretty good crop, eaten off by sheep, 2 acres planted with potatoes; manured 10 loads dung per acre; seed 8 sacks

- per acre; crop 450 bush. per acre; and $6\frac{1}{2}$ acres on land pared and burned, sown to swede turnips in May; a middling crop, 12 tons per acre; the succeeding crops have been better on these $6\frac{1}{2}$ acres than on other parts of the field.
1831. Sown with oats; seed 6 bush. per acre; crop 40 bush. per acre; grass-seeds per acre, 1 bush. of Devon lay grass; 10 lbs. of trefoil, and 2 lbs. Dutch clover.
1832. Young clover; a good crop mown for hay, $1\frac{1}{2}$ ton per acre; 300 sheep on turnips had a run here during the winter for 16 weeks.
1833. Old clover; half of field mown for hay, crop 1 ton per acre; other half fed off by sheep 200, for 9 weeks (the half that was mown was folded over by sheep and muckled during last winter).
1834. Old red-straw wheat sown by the 10th of September last; seed $3\frac{1}{2}$ bush. per acre; a good crop 36 bush. per acre.
1835. Common turnip; seed 3 lbs. per acre, sown in the beginning of July; the first sowing destroyed by the black palmer worm; the second sowing, early in August, a failure; keep for 200 sheep, 1 week only.
1836. Black oats sown broadcast; 6 bush. seed per acre; crop 30 bushels per acre, not of good quality owing to a bad season and cold wet frosts after sowing; grass seeds as in 1831.
1837. Young clover, mown for hay, crop $1\frac{1}{2}$ ton per acre; a winter's run for 200 sheep on turnips.
1838. Old clover; the western half cut for hay, crop 1 ton per acre; the other half, fed off by 200 sheep for 14 weeks; a winter's run for 200 sheep on hay.
1839. Three-year-old clover; 18 acres of the western part cut for ray-grass seed; $18\frac{1}{2}$ acres fed over by sheep, 200 for 14 weeks: in 1837-8 the part cut for seed was folded and muckled; the other part manured with 12 loads light dung per acre.
1840. Old red-straw wheat, drilled $2\frac{1}{2}$ bush. per acre; plant looking well up to March, then failed at the western end owing to the wire-worm; about 3 acres sown with barley, 4 bush. seed per acre; crop only 8 bush. per acre; 3 acres planted with potatoes, manured by 8 loads light dung per acre, crop 160 bush. per acre; the eastern part a middling crop of wheat, 24 bush. per acre.
1841. Common turnip on the eastern part 20 acres; seed 3 lbs. per acre (the land folded over by sheep in the spring and manured with 12 bush. of bone-dust and ashes drilled per acre); 2 acres sown to carrots; 3 lbs. seed per acre, well dunged, pretty good crop; 5 acres peas; seed 4 bush., no manure, but pretty good crop; 6 acres vetches, seed 3 bush. per acre; no manure; crop cut for horses and working oxen; $3\frac{1}{2}$ acres potatoes, dung 10 loads per acre; crop 160 bush. per acre; the common turnip a moderate crop.

1842. Black oats; seed 5 bush. per acre, drilled (6 loads dung per acre after peas and vetches); crop 30 bush. per acre; grass-seeds as in 1832.
1843. Young clover.
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No. 2.—North Free Down—34 acres, 2 roods, 37 perches.

- 1826-7. Digged to the depth of 9 inches; surface-soil buried.
1827. Oats; seed 6 bush. per acre; moderate crop.
1828. Western half of field left with oats self-sown; the other half with common and swedish turnip; the oats much infested with fern, &c.; crop 16 bush. per acre; 5 acres swede turnips, 6 loads dung per acre; moderate crop; common turnips, 12½ acres, land previously folded over by sheep, moderate crop; keep for 300 sheep for 8 weeks.
1829. About one-half of the oat-stubble land lying rough; the other part of field sown to white oats, seed 6 bush. per acre; crop 28 bush. per acre.
1830. Uncultivated; left in a grassy rough state for the purpose of future experiment, it being certain that until after chalking it would not pay for tillage.
- 1830-1. Nineteen acres western part pared and burned at a cost of 72s. per acre; the remainder chalked at 35s. per acre; 32½ acres sown to common turnip; a good crop; the best crop after the paring and burning; keep for 200 sheep 16 weeks; 2 acres planted with potatoes, seed 8 sacks per acre; 10 loads of dung per acre; the crop 480 bush. per acre.
1832. Oats and grass-seeds; oat-seed 6 bush.; crop 50 bush. per acre; grass-seeds (rye grass 1 bush., trefoil 10 lbs., Dutch clover 2 lbs.), winter keep on seeds for 200 sheep for 4 weeks.
1833. Clover-ley, mown, good crop 1½ ton per acre; 200 sheep on turnips running here part of the winter; western half folded over by sheep.
1834. Two years' ley; about half of it mown, crop 1 ton per acre; the other half summer fed by sheep, 200 for 16 weeks.
1835. Wheat (that part which was mown was folded over by sheep in winter, and one-half of that summer fed by sheep was manured with 10 loads of dung per acre); seed 3½ bush.; crop 32 bush. per acre.
1836. Common turnip, manured with 12 bush. bone-dust and ashes; not a good crop; keep for 200 sheep 16 weeks (6 acres eastern end vetches, 3 bush. seed per acre; not a good crop; land sown to common turnip).
1837. Oats; 6 bush. seed, pretty good crop, 32 bush. per acre; grass-seeds as in 1832; winter keep for 200 sheep for 4 weeks.
1838. Clover-ley, mown, crop 1½ ton per acre; run for 200 sheep from turnips.
1839. Two years' ley, mown, 3½ tons per acre; winter's run for 200 sheep on turnips.

1840. Three years' ley, feed for 200 sheep for 14 weeks; 8 acres of eastern end, mown, crop $\frac{1}{2}$ ton per acre; this was folded last winter with sheep.
1841. Old red-straw wheat; 2 bush. drilled per acre; plant failed on the western side owing to the injury done by a neighbour's rabbits, and was sown with barley, 4 bush. seed per acre, crop 30 bush.; 2 acres western end, vetches, seed 3 bush., part of it seeded, part of it cut for oxen; other 28 acres, good crop of wheat 28 bush. per acre.
1842. Western end peas; seed 4 bush. per acre for 10 acres; crop 20 bush. per acre; 5 acres vetches, moderate crop; this and remainder of eastern part sown to common turnip, manured with 20 bush. bone-dust and ashes; sown in July; total failure; 2 acres potatoes, 14 loads dung per acre, and 330 bush. per acre for crop.
1843. Oats.

No. 3.—Willets—37 acres, 1 rood, 25 perches.

- 1827-8. Dug to the depth of 9 inches, surface-soil buried.
1828. Oats; seed 6 bush.; crop 20 bush. each per acre.
1829. Half of it sown to rape; 3 lbs. seed per acre; very partial crop; 3 acres potatoes, seed 8 sacks, no dung; crop 160 bush. per acre; 2 acres vetches, poor crop; the remainder lying rough.
1830. Oats after rape and potatoes; seed 6 bush. per acre; crop 20 bushels; the remainder uncultivated.
1831. Uncultivated, waiting for chalk.
- 1831-2. Chalked; sown to common turnip, seed 3 lbs.; middling crop; keep for 200 sheep 16 weeks.
1833. Oats; seed 6 bush.; crop 32 bush. each per acre; grass-seeds per acre, 1 bush. rye-grass, 10 lbs. trefoil, 2 lbs. white Dutch clover; a winter's run here for sheep from turnips.
1834. Clover-seeds; mown $1\frac{1}{2}$ ton per acre; winter keep for 200 sheep for 6 weeks; the whole muckled over.
1835. Two years' ley; 12 acres hurdled off for 200 sheep for 4 weeks; the other part mown, crop $1\frac{1}{2}$ ton per acre; winter keep with hay for 200 sheep for 6 weeks.
1836. Old red-straw wheat; seed $3\frac{1}{2}$ bush.; crop 28 bush. per acre.
1837. Ten acres winter vetches; moderate crop, eaten off by sheep; 2 acres trifolium, a failure; 25 acres common turnips, manured with 30 bush. turf-ashes per acre; partial crop; keep for 200 sheep for 12 weeks.
1838. Oats; 6 bush. seed; good crop 28 bush.; grass-seeds as in 1833; the 2 acres after trifolium uncultivated.
1839. One year's ley; mown crop 1 ton per acre; winter's run for 200 sheep; 2 acres uncultivated; left for an experiment with trifolium.

1840. Two years' ley; half of it mown, crop 1 ton; 2 acres self-sown trifolium, other part summer feed for 200 sheep for 8 weeks.
1841. Three years' ley; fed off by sheep, 200 for 16 weeks; 2 acres trifolium.
1842. Old red-straw wheat; $2\frac{1}{2}$ bush. seed (some golden-drop mixed), the crop 24 bush. per acre; the whole (excepting 2 acres trifolium) manured with 10 loads dung per acre; and about two-thirds of the whole folded over with sheep.
1843. Winter vetches, hybrid turnips, peas, and rye-grass, &c.
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No. 4.—Higher Ball—34 acres, 2 roods, 37 perches.

- 1827-8. Digged to the depth of 9 inches about 12 acres on the west side; the surface-soil not buried.
1828. Oats 12 acres; seed 6 bush.; good crop, 24 bushels per acre grass-seeds sown.
1828-9. Digged east side, $22\frac{1}{2}$ acres to the depth of 9 inches; grass-seeds.
1829. Uncultivated; sheep-feed good rough grass.
1830. Ditto ditto ditto
1831. Ditto ditto ditto
1832. Oats; seed 6 bush.; crop 18 bush. per acre.
1832-3. Chalked on the rough grassy stubble, which is the best system.
1833. Common turnip, seed 3 lbs. per acre; crop very good; keep for 300 sheep 20 weeks.
1834. Oats; seed 6 bush.; good crop, 40 bushels per acre; grass-seeds sown, 1 bush. Devon ray, 10 lbs. trifolium, and 2 lbs. Dutch clover.
1835. Young clover; mown, $1\frac{1}{2}$ ton per acre; winter keep with hay for 200 sheep for 4 weeks.
1836. Two years' ley; half field mown, crop 1 ton; other part pastured by sheep.
1837. Old red-straw wheat; 3 bush. per acre; crop 25 bush. per acre.
1838. Twenty-six and a half acres to common turnip, manured with 12 bush. bone-dust and ashes; moderate crop; 200 sheep fed for 18 weeks; 4 acres beans, seed 4 bush., failure; peas 4 acres, light crop, 12 bush.
1839. Oats; 6 bush. seed per acre; crop 30 bush.; grass-seeds as in 1834.
1840. Young clover; mown, crop $1\frac{1}{2}$ ton per acre.
1841. Two years' ley; half of it mown, crop $\frac{1}{2}$ ton, half fed by 200 sheep for 12 weeks.
1842. Three years' ley; all pastured by sheep; two-thirds of field manured with 12 loads dung per acre; and one-third folded over by sheep.
1843. Wheat; dunged and sown in September.

No. 5.—Lower Ball—34 acres, 35 perches.

- 1827-8. Digged to the depth of 9 inches ; surface-soil not buried.
 1828. West part, about 12 acres, sown with oats ; seed 6 bush., crop 25 bush. per acre.
 1828-9. Remainder dug to the depth of 9 inches ; surface-soil not buried.
 1829. Two acres potatoes ; seed 8 sacks per acre ; crop 160 bush. per acre ; remainder uncultivated.
 1830. Uncultivated.
 1831. Uncultivated, excepting 8 acres vetches ; seed 3 bush. per acre ; very light crop, eaten off by sheep.
 1832. Uncultivated ; natural rough grass in abundance.
 1833. Ditto ditto ditto
 1833-4. Chalked.
 1834. Common turnip ; seed 3 lbs. per acre ; manure 30 bush. ashes per acre, crop pretty good ; 16 weeks' feed for 300 sheep.
 1835. Oats ; seed 6 bush. ; crop 38 bush. per acre ; grass-seeds sown, 1 bush. Devon ray, 10 lbs. trefoil, and 2 lbs. Dutch clover.
 1836. Young clover ; mown, good crop, $1\frac{1}{2}$ ton per acre ; run for 200 sheep during the winter.
 1837. Two years' ley ; half of field mown, crop $1\frac{1}{4}$ ton per acre ; folded over by sheep ; the other half pastured by sheep and slightly dunged.
 1838. Wheat ; 3 bush. seed ; crop good, 28 bush. per acre.
 1839. Eight acres peas ; seed 4 bush. ; crop 20 bushels per acre ; 2 acres potatoes, crop 180 bush. per acre ; 24 acres to common turnip ; manured by 20 bush. bone-dust and ashes, very light crop, feed for 200 sheep 2 months.
 1840. Oats ; pretty good crop, 34 bush. per acre ; grass-seeds sown as in 1835.
 1841. Young clover ; mown, crop $1\frac{1}{4}$ ton per acre.
 1842. Two years' ley ; mown, 1 ton per acre ; 19 acres with wheat, manured by Lance's humus and bone, 20 bush. per acre ; the other 15 acres dunged and folded over, and sown in spring with nursery wheat.
 1843. Wheat.
-

No. 6.—Bittam Field—23 acres, 3 roods.

- 1834-5. Pared and burned, and 5 acres chalked and ploughed.
 1835. Common turnip ; good crop, feed for 300 sheep for 3 months.
 1836. Oats ; crop 40 bush. per acre.
 1837. Peas ; 4 acres, crop 24 bushels ; beans 2 acres, a light crop of 16 bush. ; and common turnips, which were a good crop, feed for 200 sheep for 3 months.
 1838. All to vetches ; feed for 500 sheep for 10 weeks.
 1839. Wheat ; seed 3 bush., crop 26 bush. per acre.

1840. Four acres peas; good crop, 24 bush.; 2 acres potatoes, 320 bush.; 18 acres to common turnips, feed for 200 sheep for 3 months.
1841. Oats; very good crop, 48 bush. per acre; grass-seeds, 1 bush. Devon ray, 10 lbs. trefoil, 2 lbs. white Dutch clover per acre.
1842. Young clover; mown, $1\frac{1}{2}$ ton per acre.
1843. Two years' ley.
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No. 7.—Mare Close—10 acres, 2 roods.

1829. Barley; seed 6 bush. per acre; produce 25 bush. per acre; grass seeds, 1 bu. Devon ray, 10 lbs. trefoil, 2 lbs. white Dutch clover per acre.
1830. Clover seeds; mown $1\frac{1}{2}$ ton per acre.
1831. Two years' ley; pastured by sheep.
1832. Wheat; $3\frac{1}{2}$ bush. seed; produce 20 bushels.
1833. Swedish turnips; seed 3 lbs. per acre; 14 loads dung per acre; very good crop; fed off by sheep.
1834. Oats; 6 bush. seed; crop 40 bush. per acre; grass-seeds sown as in 1829.
1835. Clover seeds; mown crop, $1\frac{1}{2}$ ton per acre.
1836. Two years' ley, pastured.
1837. Ley, pastured.
1838. Ditto.
1839. Wheat; $3\frac{1}{2}$ bush. seed; crop 32 bush. per acre.
1840. Swede turnips; $3\frac{1}{2}$ lbs. seed; manured 14 loads dung per acre; good crop; feed for 300 sheep (store) for 10 weeks.
1841. Oats; 6 bush. seed; good crop, 40 bush.
1842. Clover seeds; mown, crop 1 ton per acre.
1843. Two years' ley.

The depth of the ploughing usually about 5 inches; but as the land has appeared to require it, the ploughing has been deeper, on one part to the depth of 12 inches.

Account of Shepherd's Corner Farm.

RECEIPTS from the SHEPHERD'S CORNER FARM, from the Years 1827
to 1842.

	£	s.	d.
1827-1842. For Wheat sold, 960 quarters	2680	0	0
Barley sold, 118 quarters	177	0	0
Oats sold, 3040 quarters	3648	0	0
Potatoes, beans, and peas	265	0	0
Winter keep of sheep on turnips and hay	690	0	0
" " hay and grass	302	10	0
Summer keep of sheep on grass, vetches, &c.	450	0	0
Keep of store cattle and other stock	160	0	0
Profit on the purchases of six working oxen and steers	80	0	0
Team-labour done for Lord Portman (not on this farm) at the usual rate of hire	1872	0	0

Balance in favour £88 11 5
And crops now in the ground.

£10,544 10 0

Mem.—The above balance is the sum in favour of the joint business of owner and occupier.

EXPENDITURE ON SHEPHERD'S CORNER FARM, from the Years 1826-7 to Michaelmas, 1842.

	£	s.	d.
1826-7. Digging 71 acres of land to the depth of 9 inches	378	9	5
1827-8. 60 acres of land to the depth of 9 inches	280	7	8
1828-9. 47 acres of land to the depth of 9 inches	221	2	6
1830. Chalking 28½ acres, carried out in boxes on doukeys and taken out in wheelbarrows	50	0	0
1830-1. Chalking	63	0	0
1831-2. Ditto	59	11	6
1832-3. Ditto	55	6	1
1833-4. Ditto	51	6	4
Chalking (at various times) (Chalking 182 acres, 2 roods, 36 perches, at 35s. per acre).	34	10	0
1830-1. Paring and burning in No. 2, 18 acres	64	16	0
1834-5. Ditto ditto No. 6, 23 acres, 3 roods	83	14	0
1832. Removing soil to open out chalk-pits, 572 cubic yards, at 4d.	9	10	8
1827. Paid for farm labour	48	10	0
1828. Ditto ditto	85	17	0
1829. Ditto ditto	107	2	6
1830. Ditto ditto	123	18	2
1831. Ditto ditto	227	6	11
1832. Ditto ditto	231	16	7
1833. Ditto ditto	217	12	3
1834. Ditto ditto	205	7	2
1835. Ditto ditto	186	1	0
1836. Ditto ditto	145	12	10
1837. Ditto ditto	168	8	8
1838. Ditto ditto	203	1	4
1839. Ditto ditto	214	10	2
1840. Ditto ditto	188	18	8
1841. Ditto ditto	193	1	8
1842. Ditto ditto	104	19	0
1827-42. Wheat-seed, 990 bushels	371	2	0
Oat-seed, 3645 bushels	546	15	0
Barley-seed, 120 bushels	22	10	0
Grass and a few other seeds	175	0	0
Seed vetches	18	3	0
Seed potatoes	52	10	0
Seed peas and beans	80	0	0
Turnip-seed	51	6	8
1827-42. Bone-dust purchased	250	0	0
Stable-dung	25	0	0
Poor, way, and church rates	750	0	0
Blacksmiths' bills, plough-irons, &c.	75	0	0
Harness-makers' bills	165	0	0
Harness, and repairing it for the donkeys employed in carrying out chalk	40	0	0
Carpenters' and wheelrights' bills, new waggons, &c.	110	0	0
Farriers' bills for 15 years	30	0	0
Purchase of horses and working steers	156	0	0
Cost of keeping horses for labour not on the farm	400	4	0
Cost of sheep hurdles	36	0	0
Rent for 15 years (being 2s. 6d. per acre previous to improvement)	1787	18	10
Tithe for the 15 years	225	0	0
Interest of capital employed at 4 per cent.	280	0	0
Buildings	632	0	0
Cost of making and rearing fences at 7s. per perch	186	11	0
	£10,455	18	7

IX.—*Observations on the Natural History and Economy of various Insects affecting the Turnip-crops, including the Surface-Caterpillars, the Turnip-gall Weevil, and the Dipterous Flies and Rove-Beetles infesting Anbury.* By JOHN CURTIS, F.L.S., Corresponding Member of the Imperial and Royal Georgofili Society of Florence, &c.

PAPER V.

HAVING fully discussed the various insects which destroy the foliage, flowers, and seeds of the turnips, I shall now treat of those which principally affect the roots. Some of these may seem to do little more than disfigure the bulb, yet it is far from improbable that the most harmless of them, by first injuring the rind, may thus lead to the decomposition of the bulb, which once begun is speedily accelerated by more active agents. Among this portion of noxious insects are many large caterpillars, called by farmers and gardeners Surface-grubs, that commit very extensive depredations upon the turnips, and likewise the Wireworm, which is the most troublesome, I believe, of all insects to the agriculturist, and will shortly form the subject of a separate memoir.

THE SURFACE-GRUBS OR SURFACE-CATERPILLARS.

Of these there are several different sorts, some less injurious than others, owing perhaps more to the paucity of their numbers than to the want of individual power to do mischief. One of our greatest philosophers was well aware of this when he said, "Insects act upon a smaller scale, but by their united energies sometimes produce great effect; the Ant, by establishing her colony, and forming her magazines, often saps the foundations of the strongest buildings, and the most insignificant creatures triumph, as it were, over the grandest works of man."* It is a fact which I particularly wish to impress upon the mind of the agriculturist, that any insect feeding upon his crops may prove a great loss to him when it multiplies to excess, and this renders it most essential that he should be able to detect the first appearance of his enemies, and watch their progress; which he cannot do with certainty, unless he will make himself master of their habits, and become so well acquainted with the insects affecting his crops as to be almost able at the first glance to detect them. When this is accomplished, he may hope to learn how to deal with the enemy opposed to him, and instead of suffering a small number of destructive insects to pass unheeded, which, as we have already shown, may multiply by millions in a few weeks, he may employ his best energies to crush immediately the worm in the bud.

* Sir H. Davy's Last Days of a Philosopher, p. 256.

The Surface-grubs have been noticed by authors more than a century ago; and in 1818, 1826, 1827, and 1836 but few vegetables escaped their ravages; and they occasioned so serious a loss to the farmer, that the Agricultural Society of Saffron Walden and the Entomological Society of London considered the subject fit for a prize-essay: in 1818, which was dry, scarcely a good turnip was left by them.* The most conspicuous of these caterpillars are the offspring of the four following moths, called "the Cabbage," "the Great Yellow Underwing," "the Heart and Dart," and "the Common Dart:" they all belong to the ORDER LEPIDOPTERA and to the FAMILY NOCTUIDÆ, or night-flying moths; but when disturbed, some of them do not refuse to fly short distances by day. The caterpillar of the first of these moths, although often secreting itself at the roots of plants, seems to live upon the leaves entirely: it ought not therefore strictly to be included in this division; but it has so often been sent to me as a Surface-grub, and is so intimately connected with the following species, which it appears will likewise feed upon the leaves as well as upon the roots, that I could not notice it in a better place than the present. It is included by modern naturalists in the GENUS MAMESTRA,† under the name of

1. *Noctua (Mamestra) Brassicæ, Linn.*, or the Cabbage-moth (fig. 1): it is of a rich brown colour; the horns are like fine threads, the feelers are very short, and enclose a longish spiral tongue; the eyes are large and hemispherical; the wings when at rest are deflexed, viz., sloping both ways, like the roof of a house; the superior are more or less variegated with dark and light brown, having many blackish streaks upon the costal or pinion edge; there are two waved strigæ formed of two black lines near the base, and another very much crenated beyond the middle; between this and the second striga are two large black circles placed transversely, and sometimes very distinct; there is also a large spot, the shape of a human ear, margined with white, and surrounded by a black line; near to the extremity or fringed edge, which is festooned with black, runs a very sinuous line, forming a W in the middle: the inferior wings are brown, dirty white at the base, the fringe whitish, with a brown line along the centre: the body is obtuse at the apex, especially in the males, and the same colour as the under wings, the extremity being sometimes ochreous, and down the back is a row of black tufts; the six legs are brown, the thighs are very woolly, the foreshanks are short, with an internal spine; the intermediate have a pair of spurs at the apex; the hinder are long and stout, spurred at the apex, with

* Major's Treatise on Insects, p. 169.

† Curtis's Guide, Genus 847, No. 7.

another pair of spurs also a little removed from them; the feet are five-jointed, spotted with ochre, terminated by minute claws, having a tooth on the inside, and little lobes called pulvilli: length $\frac{3}{4}$ of an inch; wings expanding $1\frac{1}{2}$ and upwards.

This moth is abundant in May and June; it is seen flying in the evening, and sitting in the day-time, with its wings closed, on the trunks of trees, in hedges, and on the sides of clods in fields and gardens. Last year I bred many specimens towards the end of May, during the whole of June, and in the two first weeks of July. After having paired, the female lays her eggs upon the leaves of cabbages and other vegetables; these shortly hatch, and immediately begin feeding; they are, I believe, always green in their early stages; but when they are full-grown, being as large as a goose-quill and $1\frac{1}{2}$ inch long or upwards, they vary exceedingly in colour, some being blackish above, and variegated with flesh-colour (fig. 2), whilst others are green, slightly tinged with black above, and the spiracles white (fig. 3); possibly these differences may be indications of the sexes; both have oblique lines on every segment down the back: the head is more or less ochreous and horny, furnished with short antennæ and jaws; the first thoracic segment is black above, and they have six pectoral, eight abdominal, and two anal feet. I know of no larva which is a more general feeder than this; some caterpillars will eat only of one plant, others of those which belong to the same natural family alone; but this can accommodate its taste as local circumstances may require to an extent which is surprising, making a meal indifferently of the saccharine maize or the acrid tobacco: the cabbage, however, is the favourite, or rather the most usual, food of these animals, and I saw them very abundant upon that vegetable in company with the caterpillars of *Pontia Napi*,* in July, August, and September of last year. At the same period they were devouring the turnip-leaves, and were great enemies to lettuces and rape; they were likewise particularly fond of the Indian corn, living amongst the male flowers, and also in the brush of filaments which crowns the female spikes, frequently eating it smooth off. I was surprised to find great numbers feeding upon the leaves of the scarlet geraniums in a large garden-bed, the beauty of the fine foliage being impaired by the multitude of large holes they had eaten in the leaves; and in October they attacked the leaves of some red currant bushes: at the same time I found them feeding freely in my breeding-cage upon the poplar, notwithstanding a cabbage-leaf was there also. Although they seem to refuse none of the productions of the field or garden, it is those of the latter which suffer most from their assaults.

* Royal Agric. Journ., vol. iii. p. 312.

In the summer and early autumn months, when the cauliflowers and cabbages have a well-formed heart, these ravenous caterpillars not only consume a great portion of the plant, but render it altogether unfit for culinary purposes by the disgusting deposit which falls from them, tainting every leaf; and it is scarcely possible to detect them, unless the vegetable be cut through and even into quarters, as they eat their way into the most solid parts. This insect is abundant in all the countries of Europe where cabbages, lettuces, &c. are cultivated; and M. Godart* says, "It is extremely common in France, where it is the greatest scourge of the kitchen-gardens. It devours all the plants we cultivate, but principally the different sorts of cabbages, giving the preference to the *Brassica capitata alba* (the cauliflower). From quitting the egg until its last moult, it not only attacks the exterior leaves of that plant, but it penetrates afterwards into the heart; and as there are generally many together, they hollow it out entirely without any external indications. In countries where the tobacco is cultivated, they equally attack that plant, in spite of its acrimony." When full-grown, some bury themselves in the earth and others rest upon the surface, and change to chrysalides similar to fig. 14, but smaller, of a chestnut colour with a pitchy shade; they are often enclosed in cases formed of the surrounding mould, and thus pass the winter securely: but many of them do not change to pupæ until April. The moths, as before stated, issue from these cells in May or June.

The most certain means of getting rid of these troublesome caterpillars is to look over the plants carefully and destroy them; and as they frequently hide themselves by day under the earth, when they are in their last skins, the search might be more successfully pursued at night when they come forth to feed.

The second species now forms a portion of the GENUS *TRIPHÆNA*,† and is called

2. *Noctua (Triphæna) pronuba*, Linn.; the Great Yellow Underwing (fig. 4). This moth varies greatly in the colour of the thorax and the upper wings, which are sometimes of a dull ochraceous or clay-colour, at others of a deep chestnut-brown, and there is an intermediate variety more fulvous and variegated with bright brown; the feelers are pointed, forming a beak to the head, and between them is a longish spiral tongue; the horns are slender and setaceous, like bristles; the eyes large and semiglobose; the thorax is large; the wings when at rest cover each other horizontally, being depressed; the superior are long, and have two double-waved strigæ towards the base

* Hist. Nat. des Lep. de France, vol. vii., p. 38.

† Curtis's Guide, Genus 843, and Brit. Ent. fol. and pl. 348.

and another beyond the middle; on the disc are two spots, one oval, the other ear-shaped, with the centre more or less black, and towards the apex and close to the costa are two black spots; with the exception of these spots and the dark ear, the markings often vanish as in the specimen figured; the inferior wings are ample, and of an orange-colour with a blackish border, not reaching the margin, the edges being waved, broadest above, and narrowed towards the anal angle; body depressed, fulvous-orange, deepest at the apex, which is broadest in the males: legs six, long and dark rusty-brown; first pair of shanks short, with an internal spine; intermediate, with a longish pair of unequal spurs at the apex; hinder, long with similar spurs at the apex, and another pair near the middle, all spotted with ochre; feet long, five-jointed, and rough beneath, with rows of short bristles; claws minute, with a tooth on the inside: length upwards of an inch; wings expanding nearly $2\frac{1}{2}$ inches. There is also a variety with the fore-part of the thorax, the upper side of the feelers, and the costa of the superior wings, as far as the middle, of a paler colour than the other portions of those parts; this variety has been named by the German naturalists, *Triphæna imnuba*.

This large and beautiful moth is very abundant in most seasons during hay-making, viz., from the beginning of June to the middle of July, in fields, gardens, and hedges. On turning over the cut hay in the morning, I have seen multitudes which had sheltered there, spring up and fly a few yards, when they generally dropped down and again secreted themselves amongst the grass. I believe they are found throughout Europe, and Mr. Lyell observed one on Mont Blanc, the 7th of July, 1818, above the height of perpetual snow, which proves how well even the moth can resist a low temperature.

I have frequently received the caterpillars of this moth with other Surface-grubs, and in November, 1841, the Rev. C. Clarke, of Henstead, in Suffolk, sent me several, which he found with others of *A. exclamatoris* (fig. 7) at the roots of the turnips; from which it is evident that they either feed upon the bulbs or the leaves, perhaps upon both, which is rather remarkable, because some authors state that they live upon the roots of grass, and this opinion seems to be confirmed by the moths inhabiting hay-fields in such abundance; on the Continent, however, they eat many of the cruciferous plants, especially the Shepherd's Purse (*Thlaspi Bursa-pastoris*), and they are said to be equally fond of the groundsel (*Senecio vulgaris*). These larvæ conceal themselves during the day, and come out to feed at night; they are either of a dirty-green with a coppery tinge, or of a yellowish-green variegated on the back and sides with rosy-brown and minutely freckled; the underside is pale green; the head is

ochraceous, with two black stripes in front and a fuscous spot between them; the first thoracic segment has a brownish or black lunule above, but not glossy; there are three pale lines down the back, the central one being the narrowest, the other segments having a blackish streak on the inside, excepting the first four, forming seven long spots, the twelfth segment is green with four fuscous spots, and the apex is brown; the spiracles are black, the head and tail slightly hairy, and there are a few short hairs scattered over the body; they are very fat, but not in the least shining: they can walk and cling pretty well; the six pectoral feet are ochreous, the other ten have the coronets black: they are $1\frac{3}{4}$ of an inch long, sometimes as thick as a swan's quill (fig. 5).

These caterpillars live through the winter, and can bear very severe cold; for I took one home that was embedded in ice in December on an inundated meadow, and it not only recovered, but ate a hole in a plantain-leaf in the spring: they frequently hibernate just beneath the turf or surface of the soil, and come out again to feed in the spring; they finally bury themselves in the ground about April, when they form cases of the earth, and change to large chrysalides of a bright reddish brown, like fig. 14, from which the moths emerge early in the summer.

These larvæ are often alluded to by gardeners as a very troublesome species, and there seems to be good evidence of their being so, for we have shown that this variety is undoubtedly one of those Surface-grubs which infest the turnips; but unscientific men are very vague in their descriptions, and often confound a number of things under the name of grubs; this is not surprising when we are aware that nothing is more difficult than to trace these animals through their different skins and transformations, since they vary greatly in colour, live a long time, and notwithstanding the greatest care and attention they often die in the chrysalis state. If the writer be correct as to the identity of the insects, the following statements by J. D. will at once show how mischievous this caterpillar is:—"Early in May, 1833, I sowed a small bed of onions; a plentiful crop arose, but from then till September 12th the plants have kept withering until half are gone. As the herbage was in some cases wholly, in others partially eaten through at the earth's surface, it seemed clearly the work of insects; but I could find none. The bulb was partly decayed as well as eaten. Since the soaking rains which fell on September 1st, 2nd, and 3rd, the onions disappeared altogether at one end of the bed, and this sight prompted me on the 14th of September to dig the whole up. The bed was 7 feet long by $3\frac{1}{2}$ wide; and in this area I found forty-seven grubs, most of them full-grown, some of

them quite so, I suppose of *Noctua pronuba*.* In another place he says, "The grub of this moth is that yellowish-brown, tough-skinned grub† which every gardener has seen repeatedly on and just under the very surface of the soil, where it eats through the collar or stem of the young cabbage-plants, &c., and from numerous observations I have concluded that it prefers the cruciferous plants of any or every genus to the plants of other natural orders, as the *Cruciferae* have all, in a greater or less degree, a mustard flavour. Seven or eight years ago it destroyed, on the farm of C. Harrison, Esq., at Bury St. Edmund's, numerous young plants of turnips, when possessed of seven or eight leaves, by eating through their incipient root-stalks or bulbs; hereupon the plants would fall aside and die: they produced the *N. pronuba*."‡

The two following very destructive species are included by our present system in the *Genus Agrotis*;§ their larvæ appear to be very similar, and their economy precisely the same.

3. *Noctua (Agrotis) exclamatoris*, Linn., the Heart-and-Dart moth (fig. 6), has received these names from the markings of the wings resembling a note of exclamation and a heart and a dart. It is of a clay-colour; the horns are like fine bristles, but in the male they appear slightly toothed like a comb, most distinctly near the base, in consequence of each joint producing a fringe of short hairs: the feelers are short and almost black beneath, with a little joint protruding at the apex, and between them is a strong spiral tongue; on the front of the thorax is a transverse black spot; the wings repose in a horizontal position, being then flat, with one of the superior lying over the other as in the Great Yellow Underwing; the superior wings are rather long and narrow, darkest at the costal edge, which is spotted with darker and paler marks; there are two waved double lines near the base, and to the second is attached an elliptical piceous streak; above it is a ring with a pupil, and beyond this a dark ear-shaped mark; then follows a transverse denticulated line, and nearer the fringed margin a pale and very irregular line: the inferior wings are white, excepting the upper margin and the nervures, which are brownish: the body is a little depressed, dark-brown, lighter at the base; the apex obtuse in the male, conical in the female; the six legs are long and piceous, the fore-shanks are short, and have an internal spine; the intermediate have a pair of unequal spurs at the apex, as well as the hinder, which have likewise another pair at the

* Gardener's Mag., vol. ix., p. 573.

† This sentence rather alludes to the larva of a *Tipula*, I should say.

‡ Gardener's Mag., vol. ix., p. 504.

§ Curtis's Brit. Ent., pl. and fol. 165; and Guide, Gen. 834, Nos. 11 and 16.

middle, and are ciliated outside at the base :* all the feet are five-jointed and spiny beneath, terminating in minute claws with a tooth on the inside, and furnished with little pulvilli: the tips of the shanks and of all the tarsi are whitish. The *female* differs from the male in having simple and not pectinated horns, and the underwings are dark-brown, instead of white: length $\frac{3}{4}$ of an inch, expanse not quite $1\frac{1}{2}$.

This moth is exceedingly abundant all over Europe, and it is even a common insect at the Cape of Good Hope. There are two broods of it annually in France, and it is found plentifully in England in June, mostly towards the end of the month, in fields and gardens, on weedy banks, &c., about which it flies at the close of day. The eggs laid by the female produce larvæ, which are said to live upon the groundsel; but that is doubtful, for a friend and myself have bred this moth from the caterpillars which were found at the roots of turnips; it is possible they feed upon both. However this may be, it is a most destructive animal to crops of this valuable plant, and sometimes in company with the following species destroys immense numbers at every stage of their growth. Towards the end of last August in Surrey they attacked the margins of a field of swedes under a hedge full of elm-trees; some of the plants were observed to be dying, and on being pulled up, the crown was found separated from the root, as exhibited at fig. 8, and on searching there, one of the caterpillars was discovered; but in a neighbouring enclosure as many as four were detected at one root, and they had spread themselves into the middle of the field. There can be no doubt that this, like the other species, lives through the winter; for a friend in Suffolk supplied me with a considerable number of the caterpillars on the 20th of November, which were taken from the roots of potatoes in one of his fields.

This caterpillar, fig. 7, is of a dull lilac-colour, with a broad space down the back more ochreous and lighter, the margins being bounded by an indistinct but darker line, and there is a double fuscous line down the centre; the underside is pale dull whitish-green; the head is brown; the jaws, eyes, two oblique lines at the base, and a dot between them, black, as are the nine spiracles also; the first thoracic segment is rather horny, and brown above, variegated with darker spots; the other segments have four little tubercles on the back of each, and several on the sides, all of them producing a short hair: the six pectoral legs are ochraceous, the claws black, the eight abdominal and two anal feet are brown at their extremities; they are full $1\frac{1}{2}$ inch long, and as thick as a small goose-quill. This is not so cylindrical

* Curtis's Brit. Ent., pl. 165, fig. 8t.

as the other species are, being somewhat depressed above and flattish beneath, which is probably a better form for burrowing under the roots; they walk rapidly, but cannot stick fast by their feet, and consequently soon fall off anything they are placed upon: the chrysalis like the others is formed in the earth.

Another species belonging to the same genus, and equally if not more destructive, is the offspring of a moth which has been named by Ochsenheimer

4. *Noctua (Agrotis) Segetum*, the common Dart-moth (fig. 9): it is generally of a reddish-brown, but varies so greatly in the tint of the upper wings, which are sometimes of a clay-colour, as well as in the strength and shape of the markings upon them, that Mr. Haworth has described it under nine different names in his '*Lepidoptera Britannica*.' The feelers, tongue, and horns are like those of *A. exclamatoris*, but the latter are more decidedly pectinated in the males;* the wings are also placed in the same way in repose as in that species; the superior are freckled with brown, there are two double-waved lines across the base, to the second of which is attached a black oval or elliptical spot, margined with black; on the disc is a ring circled with black and dark in the centre, with a large ear-shaped spot by its side of the same tint; beyond these is a double indented and waved line, and near the margin a still more irregular one; at the base of the fringe is a row of black lunate spots: the inferior wings are pure white with an opalescent shade, the nervures and a line along the margin are fuscous; the body is brown, palest at the base: the six legs are grisly, but formed like those of *A. exclamatoris*. The female is much darker, and the horns are simple: the head, thorax, and upper wings are deep chocolate or brown, the markings, so visible in the males, being almost obliterated in this sex: the under wings are dirty-white, softening into fuscous at the margin, the nervures being of the same colour: length from 8 lines to $\frac{3}{4}$ of an inch, expanse from $1\frac{3}{4}$ to 2 inches.

This moth is sometimes seen flying in multitudes about the tops of hedges soon after sunset, in June and July, and I have taken it on the sand-hills near Sandwich in the middle of October; from this it may be inferred that there are either two broods in a year, or that there is a constant succession of them during the summer and autumn months. It seems to be universally distributed, being found in almost every part of Europe, and, like the foregoing species, is equally common at the Cape of Good Hope. The females lay their eggs in the earth in the month of August, or earlier, and the young caterpillars emerge from the shells in about ten days or a fortnight, and after living through the winter

* Curtis's Brit. Ent., pl. 165, figs. 1 and 1^b.

they attain to the length of $1\frac{1}{2}$ or nearly 2 inches, when they are as thick as a small goose-quill. They are smooth and shining, and of a pale lurid ochraceous colour, faintly freckled, with a broad space down the back often rosy, and a few short hairs scattered over the body; down the centre is a double dark line, with another less distinct on each side; between these are two black dots placed obliquely on each segment, and likewise three black dots on each at the base of the thighs: like the foregoing species they have six pectoral, eight abdominal, and two anal feet: the head is horny, the mouth and little horns are rusty, the minute jaws black: the eyes are ochreous dotted with black, the internal margin being edged with the same colour, forming nearly a \times on the face: the first thoracic segment is brown divided by three pale lines; it is very horny and shining, which is much less the case in *A. exclamationis*, and not at all so in another species (fig. 12): when disturbed they roll themselves up, but do not remain long before they are again in motion (fig. 10).

On the 7th of June last year, Mr. C. Parsons sent me some of these caterpillars from Essex, which were nearly full-grown; they were doing great mischief to the young mangold-wurzel plants, the roots of which they ate through just below the crown, as shown at fig. 11; they also attacked the potatoes when just pushing out of the ground. They were exceedingly voracious, and fed freely upon lettuce-leaves which I gave them: they lived some time in a garden-pot containing a turnip-root and a potato, but eventually died, I believe, for want of more moisture. The second week of last August I received a considerable number of the same sort from a crop of swedes in Surrey: the field had been wheat, was ploughed in the autumn, got ready for turnips, and sown all at once at the usual time. In September, 1839, a field of swedes at Farnham, in the same county, was entirely destroyed by these caterpillars, many of which I endeavoured to rear, but they all died in the winter: they lived underground, and ate large holes in the roots, and came out at night to feed, apparently upon the leaves. In August and September, 1835, they were exceedingly numerous in Suffolk, and did considerable injury to the bulbs of the turnips. In November, 1841, I received a considerable stock from the Rev. C. Clarke; they were then actively engaged in eating large holes in the bulbs, which, being soon filled with earth, were thereby rendered very difficult to clean, and not so beneficial to stock. At an earlier period of their lives, and about the second hoeing in July, their economy was a little varied, for they then ate off the whole crown of the plant a little below the surface, and separated it from the bulb in a similar way to fig. 8.

These caterpillars will attack the roots of a great variety of

plants, especially those of corn; from whence they are called in Germany "the Winter Corn-moth." In that country they are sometimes very destructive to the autumn-sown corn, and likewise in Russia, from whence they have spread over Poland into northern Germany and Prussia;* and so great were their numbers at intervals, that many districts have been threatened with famine from their ravages. This caterpillar is likewise a troublesome visiter to the gardener as well as the farmer, for it not only destroys the corn and turnip crops by eating up the roots and leaves, but it attacks lettuces, spinach, beet, and also a variety of flower-roots, as auriculas, &c., doing the greatest mischief in seedling beds. Upon the continent, as the harvest is early, these larvæ are at that period generally compelled to subsist upon the roots of grasses, but as soon as the corn shoots up in September and October they resort to the tender roots for food; and this shows how essential it is to keep the land clean, by collecting and burning the bent-grass and similar weeds, for in the absence of these it is far from improbable that the eggs would not be laid, or, if they were, that the caterpillars when hatched would speedily be starved to death. They pass the winter in a ball of earth the shape of an egg, formed 2 or 3 inches below the surface, in the cavity of which they are completely protected both from frost and wet. In the early spring the caterpillars leave their winter-cells and again feed, without doing much injury, until the end of May or beginning of June, when they finally enter the earth to undergo their transformation to a brown chrysalis, in which state they generally remain a month, when the moth is produced. The seasons and climate, as well as the causes already alluded to, may occasion a considerable difference in the periods when the perfect insect comes forth, for it is said that in France the moth does not appear until the end of July or the beginning of August, whereas in Austria it is recorded as hatching at the end of June or beginning of July, as it does in England.

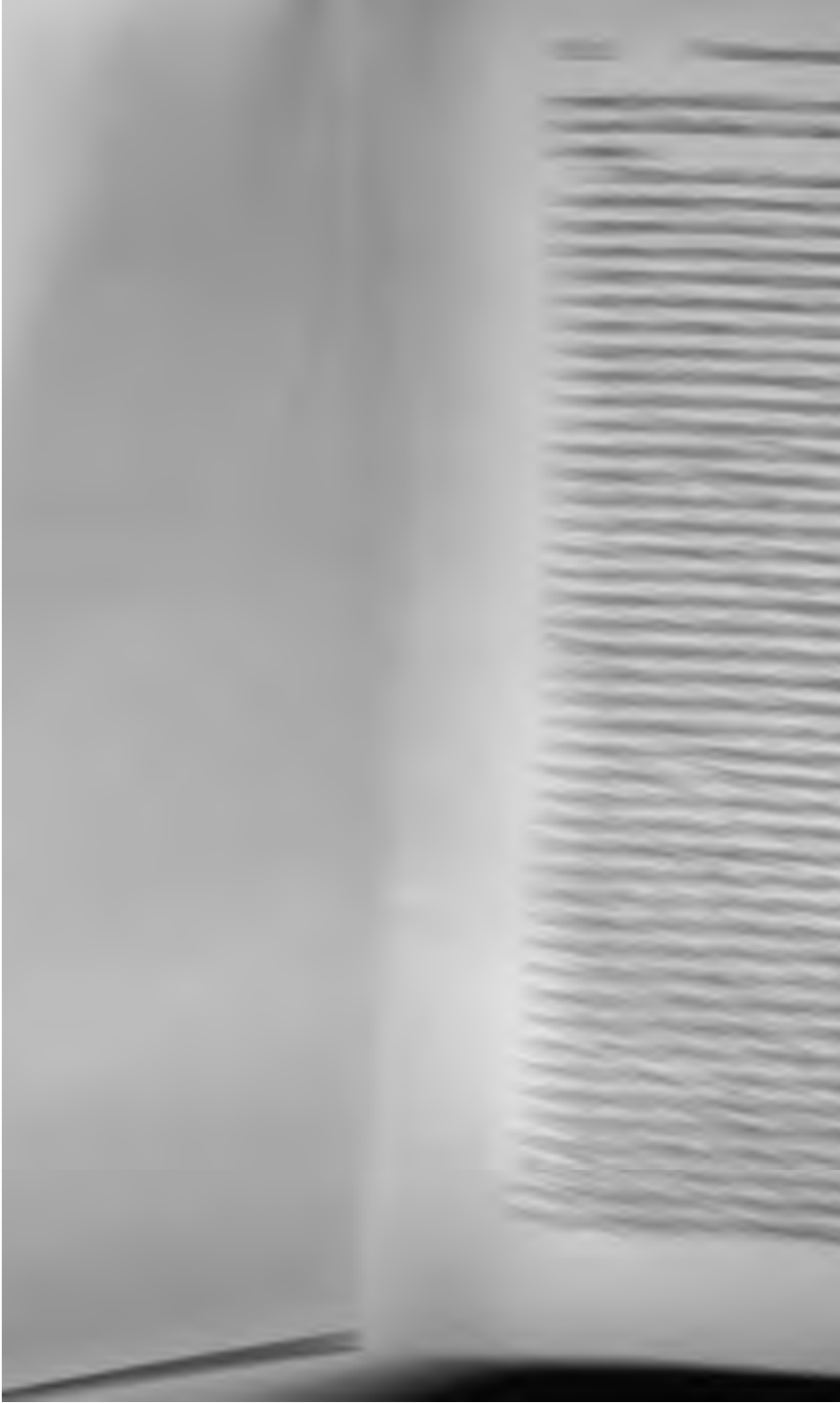
The economy of this caterpillar has been faithfully related by a very careful observer of nature;† and as his account embodies some facts which have not come under my own observation, I cannot do better than conclude its history by transcribing his remarks: "The grub is also a very formidable assailant in the more advanced state of the (turnip) plant, near to which it forms a round hole in a vertical direction (in appearance like that of an earth-worm, but open at the top), about 2 or 3 inches deep in the earth. At the bottom of this it remains during the day (unless it be dark and moist), and at night emerges from its

* Kollar's Nat. der Schad. Insecten, p. 106.

† Mr. H. Le Keux, in Trans. Ent. Soc., vol. ii. p. 32.

burrow and commences an attack upon the plant by eating round the neck of it, and eventually detaching the upper part from the root; or a single leaf is eaten through at the stem, and when fallen on the ground, the nearest edge is dragged to the burrow, where it is drawn in and devoured during the day. Last year (1836), the turnips sown on the south side of a hill having entirely failed, it was ploughed in furrows, and each filled with yard-dung, and the earth turned over it by the plough; and on the first rainy day a number of young plants of the Swedish turnip (thinned out from a patch in a moist situation on the north side) were planted on the ridges 18 inches asunder, and very soon grew remarkably strong and healthy; but after the few straggling plants in the part left unploughed had been destroyed by the grub, then those at the extreme ends of the ridges began to disappear, and plant after plant followed from the same cause, until very few were left. Having noticed one fine plant at a distance of 6 or 7 yards from any other, and that a grub had just formed his burrow and begun to attack it, I dissolved $\frac{1}{4}$ of an ounce of common salt in a quart of water, and poured it over the plant, taking care not to let any run into the hole, or to disturb the grub. When I examined the plant the following day, no further injury had been done to it, and on digging up the burrow I found it had been deserted by the grub, which I have no doubt had travelled to the next plant, although at least 6 yards distant, for there I found a burrow and a recent attack upon the plant which the day before was uninjured. I now washed this also and several others with the solution of salt, and for ten days (during which the weather was hot and dry) no one of them received further injury until a heavy shower of rain fell, after which (as I did not wash them again) they shared the fate of all the others. In such cases it might be worth while to employ children to dig them out, for they are easily found, as may appear from my having collected upwards of thirty in less than half an hour; but the most keen searcher for, and destroyer of these is the rook, and I attribute their increase in this instance to the mistaken vigilance of the farmer in shooting any one of them which ventured to set foot upon the land, and hanging him up as a warning to his brethren of the reward they would meet with for any friendly endeavours to relieve him from the ravages of so destructive an enemy as the grub."

One cause of the great mischief arising from the attacks of the caterpillars of this and the preceding species is, their capability of travelling at a very rapid rate from one spot to another; for in this way, as soon as a caterpillar has eaten through the root of a young plant, it marches off in quest of another, and thus the evil is greatly multiplied; and on removing a little of the earth sur-



There seem to be very few, if any, intervals of the year, when some of these surface-grubs are not at work; they consequently become very formidable enemies to the turnip-crops where they abound: in the summer it is evident that they destroy the young plants by separating the crown from the root, and in the autumn and in mild winters they eat large cavities in the bulbs, which, besides making them less wholesome food for stock, reduce their weight, and render them more subject to decay, from the alternate effects of wet and frost: those caterpillars, likewise, which live through the winter and come out to feed in the spring, are ready to attack any young crop that may be conveniently reached by them.

I shall now lay before the agriculturist the various methods that have been suggested for the destruction of these caterpillars, for whilst in the egg state, which appears to be seldom earlier than midsummer, the fields are producing their crops; it is therefore at least inconvenient to attempt, if not impracticable, to do any good, except perhaps on fallows, by ploughing, harrowing, and working the soil, which must be one of the most effectual means of rendering the attacks of most, if not of all, insects abortive, at least after the first assault, for nowhere do they increase and luxuriate more than on neglected and slovenly cultivated lands. Like many other wild animals they will multiply greatly in a favourite spot if unmolested; but when harassed and disturbed, they will depart for a more eligible locality. Neatness therefore, and constant attention to the crops, are as essential in the field as in the garden, and they will be attended with the same beneficial results as care and cleanliness ensure in the fold and stable when bestowed upon our stock and teams. There is likewise little doubt, from the astonishing sagacity which insects exhibit, that the females would only lay their eggs in fields where there was a fair prospect of the young caterpillars finding at once the food necessary for their sustenance; for so perfect is their instinct, that a butterfly will traverse a wood in every direction to find a leaf of the tree on which alone her caterpillars will feed. This is very astonishing, for what impulse can lead the butterfly, which for her own nourishment only extracts nectar from flowers, to a certain kind of tree, there to deposit her eggs upon the most sheltered part of the foliage?*

* I was in an extensive wood last April where I saw only *one tree* of the Alder-Buckthorn, *Rhamnus Frangula*; hovering about it I observed a female Brimstone Butterfly, *Gonepteryx Rhamni*, the larva of which feeds only upon that and the common Buckthorn: she seemed to have some difficulty in selecting a proper leaf, but, having done so, she bent her body and deposited an egg on the underside; and although I went within a few inches of her to witness the operation, nothing could divert her from her purpose, but immediately after she flew away.

the divine law of the Creator which directs the insect in its ways as well as the planet in its course !

As it appears to be impracticable to destroy the eggs, we must attack these creatures when they are in the caterpillar or feeding state, and even at that period of their existence we know nothing at present, until they are more than half-grown, and their presence is only detected by the mischief they are doing. Even then it is difficult, as it is in most cases, to apply a *certain* remedy ; but as they come out only in the evening, to feed during the night, lying concealed by day in the earth or under clods, stones, and rubbish, it is evident that the proper time to apply any destructive liquids and powders must be after sunset. Tobacco-water will, for instance, kill the surface-caterpillars, if it come fairly in contact with their skins ; but if the turnips were profusely watered with that liquor in the daytime, I suspect it would not destroy a decimal part, since those in the earth would descend to a greater depth as soon as they detected the hateful shower.

Bouché says that in a garden the only remedy, which is a very troublesome one, is to search for and kill these caterpillars. Kollar also believes the best method is to collect them into pots and kill them with hot water, when the tub, which may be placed where most convenient in the field, is sufficiently full, or the labour is ended ; of course the vessel must be closely covered to prevent their escape. The value of being acquainted with the habits of insects is very manifest with regard to these caterpillars, for any one ignorant of their economy might search for them in vain. The best plan to be adopted will be to turn over the stones and clods by day, and to pick them off the plants after sunset with a lantern ; and occasionally they may be found in the day, when they leave their hiding-places to change their skins or to fix on a suitable spot to undergo their transformation to a chrysalis. Kollar remarks that the operation of collecting, like all others of a similar nature, should be simultaneous on a farm or in a parish, and requires the united force of the neighbourhood, without which anything like extirpation cannot be effected. When turnips or cabbage-plants have been bitten off in the night, the soil should be removed as soon as possible from the stem or root, to the depth of an inch or two, where the enemy will generally be found secreted and enjoying his repose.

Mr. Denyers recommends laying dry soot an inch thick over the ground and digging it in :—" In the grub's attacks on plants of the cabbage family, its habit is to eat some nearly and others quite asunder, a little below the heart : it often greatly annoys the farmers in their turnip-fields. I have made use of the above remedy and have never found it fail."* Mr. Mathers also says,—

* Gardener's Mag., vol. ix. p. 573.

"In May, 1829, my plants of cauliflowers and cabbages were all going off by the grub, which had totally destroyed the lower part of the root; but by applying a small handful of soot to the stem of each and earthing them up immediately, they threw out fresh fibres, which very much astonished me, and the plants grew more rapidly and made very fine heads."* From these reports it seems that soot is very offensive to the surface-grubs, and most probably would be very beneficial at the early stages of the turnips, but we fear it is too difficult to procure in sufficient quantities, as well as too expensive, for field culture.

Another correspondent in the same Journal says,—“The Brown-grub is a mortal enemy to lettuce, celery, and all the cabbage tribe; wherever their depredations are observed, dig below the eaten plant, find the insect and destroy it, otherwise another plant will be devoured on the morrow. A little fresh slaked lime laid round each plant will defend it, unless the grub rises directly from below.”† At a meeting of the Entomological Society in December, 1836, specimens of the caterpillar of *Agrotis Segetum* were exhibited by Mr. Yarrell, “which had been forwarded to him from Saffron Walden, where they had been very destructive to the turnips, five or six attacking the roots of that and other kinds of plants. Mr. Scales also exhibited larvæ of apparently the same insect, which had been equally destructive in his garden at Stoke Newington, the caterpillars coming abroad at night and eating round the roots and vegetables just at the surface of the ground.”‡ In November, 1835, Mr. Hope stated at a meeting of the same Society, that the larvæ of an *Agrotis* had proved very injurious to the turnips in Shropshire, Herefordshire, and Worcestershire, hiding themselves in the ground in the daytime and coming forth at night to feed upon the leaves. “He suggested that the application of quicklime over the turnips after rain at dusk would have the effect of destroying the larvæ when they came forth to feed, and likewise that it would be serviceable to turn poultry and ducks into the fields when ploughed.”§

Mr. Major|| says that, on a small scale or in the garden, their ravages may be mitigated by clearing the ground well of all weeds or other vegetation a week or fortnight previous to sowing the seed or pricking out a bed, which will cause the caterpillars to leave it in search of food. He proposes also planting a decoy for them by surrounding the seed plot with a row of cauliflowers, cole, brocoli, or any similar vegetables which can be spared; of course if any of the larvæ be there they will be attracted to the plants, and by searching daily a few inches below the surface

* Gardener's Mag., vol. vii. p. 87.

† Trans. Ent. Soc., vol. ii. p. xxx.

‡ Treatise on Insects, p. 169.

§ Ibid., vol. iv. p. 187.

|| Ibid., vol. i. p. lxxvii.

they may be readily detected and destroyed. As soon as a leaf of the young plant dies or the top droops, immediately turn up the earth with a trowel, and the enemy will be found at the root; but if this be neglected only for a few hours, he will have departed to another plant. He also recommends mixing 1 lb. of soap with 16 gallons of water, and applying it in a warm state to the roots, until it sinks into their burrows. "This will cause them to dart out of their cells with their heads upwards, where they stand perpendicularly as if they were completely killed; they must however be quickly collected, as they will recover in 10 or 15 minutes and retire again." He adds "that the only remedy favourable to extensive crops will be, instead of shooting and frightening the rooks, to use every encouragement to induce them to resort there, that they may gather the grub for sustenance." If this favours the small birds also, which he thinks gather the seed and eat the heads of the plants, the mischief may be averted by dusting them over with quicklime while the dew is upon the leaves; this should be done as soon as the plants appear aboveground, and ought to be repeated in two or three days. The rooks are often accused of doing great mischief to crops attacked by the grub, for they not only search at the roots of the infested plants, it is said, but they pull up all as they go. The rook is so sagacious that I would fain release him from this accusation: when he thus pulls the plants about I suspect that slugs, wire-worms, and grubs are at the roots; if he did not kill them, the plants must die, and without his aid the insects would remain; it is therefore clear that the farmer is a gainer by his services, inasmuch as he gets rid of the vermin which infest the soil, so that at all events his succeeding crops will be free from their attacks. To ascertain the real value of the services of birds in keeping under noxious insects, let any one kill them all off if possible, and the reward of his folly will be a dearth on his land. If the rook does live sometimes at the farmer's expense, let him not forget "that the labourer is worthy of his hire."

Pigs are also very fond of the grubs, and these, as well as ground-nuts and other roots, afford them a fine feast on waste lands, and cause them to root up the ground: whether they could be safely employed to search for the Surface-grubs is questionable; if they might, I think they would prove most serviceable agents in their destruction when fields are swarming with them late in the year.

The chrysalides are so securely enveloped in a ball of earth, the cavity being smoothed perhaps by some fluid from the mouth or body of the caterpillar, that it is probably unaffected by the sharpest frosts and impervious to the heaviest rains; it is therefore useless to attempt to destroy them in that tranquil state by water-

ing or dusting; and catching and destroying the moths, if practicable, would not be an effectual remedy, for the females would escape the strictest search, their colours being so grave and similar to the earth, that no one could discover them when at rest in the daytime; and fires or other means employed at night to attract and destroy the moths would only reduce the number of *males*, leaving the females, which seldom fly, and a sufficient number of their mates, to supply the succeeding generations.

Although the following remedies apply to corn-crops when attacked by the Surface-caterpillars, I shall introduce them here, as they may bear in some measure upon the turnips and guide the farmer when they visit his lands.

Late sowing, as it regards corn, would prove the best security in autumn, because the larvæ would in all probability be starved to death before the roots of the corn were ready for them, and it is believed that the female moth takes advantage of a fresh-ploughed field to deposit her eggs in the soft and moist earth; if this be the case, June and July are the most improper months for sowing turnips, so far as regards these caterpillars. The richer the soil, the warmer the situation, and the earlier corn is sown, the more are the attacks of the Surface-caterpillars to be dreaded, as they immediately destroy the immature roots of spring corn. Soils rendered strong and warm by horsedung-manure are most infested by all sorts of larvæ and worms, which is supposed to arise from the heat that is generated by the fermentation accelerating the hatching of the eggs.

Steeping the seeds in liquor extracted from bitter herbs,* mixed with salt or nitrates, can be of no use unless, by forcing the germinating power, the plants are enabled to outgrow the injuries they have sustained. If any salts, especially nitrate of ammonia, were mixed in sufficient quantities with the soil, there can be no doubt of their securing the crops, and, thus applied, liquid manure might prove most beneficial. Kollar expresses a fear that, if the seeds were rendered bitter and disagreeable to the insects, the same properties would be communicated to the grain, thereby making it unfit for use, but this opinion is not supported either by physiology or experience.

The Royal Academy of Sciences in Sweden † recommended one-eighth of a ton of slaked lime to be sifted over 1 ton of wheat when spread out, and to be well mixed with it; the whole is then to be tied up tightly in sacks and laid under the straw in the barn for three days, until the wheat becomes thoroughly heated, after

* Mr. Main states that "watering April-sown cauliflower-seedlings with an infusion of the leaves of artichokes, a liquor bitter enough, will not preserve them."—Vide the Gardener's Mag.

† Kollar's Naturg. du Schäd. Insect., p. 111.

which the corn and lime may be sown together in calm weather. Scattering ashes immediately before and after sowing the seed, or when the plants begin to shoot up, might prevent these caterpillars from attacking a crop or drive them away. The same Society states, on the authority of many farmers, that corn has been effectually protected from seed-eating caterpillars by sticking inverted young fir-trees, having the tops first cut off, into various parts of the field! If this be correct, we are at a loss for an explanation of the phenomenon; yet it is maintained, so certain is the effect, that if the caterpillars had already infested a field it would cause them to vanish.

Kollar is of opinion that the advantages derived from sowing hemp round the borders of a field do not arise from any disagreeable scent being imparted, but from its attracting small birds, which resort to it for its seed and for shelter, and, by feeding upon the hurtful insects around them, they greatly diminish their numbers. It is difficult to account for the absence of the Surface-caterpillars from our field-crops for many years together, unless, as is generally the case, they are occasionally overpowered by parasitic insects; it is therefore not a little remarkable that I have never met with any of the parasites which we may presume are attached to these caterpillars; it is true that, as far as regards the *Noctua Brassicae*, I find in gardens in June and July great numbers of an Ichneumon called *Exetastes osculatorius* of Fabricius,* which appears to accompany that species, but, never having bred it, I have no direct evidence of their being connected in their economy.

I shall conclude the history of the Surface-caterpillars by giving directions for the rearing them, trusting that it may lead us to a better knowledge of some parts of their history. When we take any caterpillar or other larva of an insect from the field or garden, the nearer we can approach to keeping it in its natural state, the better chance we shall have of rearing the perfect insect; whether moth, fly, or otherwise: the first object is therefore to plant the food it requires in the right soil; but if the larva feed upon the leaves or flowers of a tree or plant, a twig may be cut off and placed in a vial or small bottle of water in the cage: the next thing is to keep the earth enclosed sufficiently damp but not too wet, and this is most difficult. The best mode undoubtedly is to take a butter-firkin or small useless box, and bore the head or bottom full of holes, which are necessary to drain it, but not large enough to allow the animals to get through; then sink the barrel in a shady yet airy spot in the garden, within 6 or 8 inches of the surface: this being done, fill it with the proper soil to the same

* Curtis's Guide, Gen. 524, No. 15.

level, so as to leave enough space for the growth of the turnip, potato, corn, or whatever is required for the sustenance of the larvæ: if the sun shine upon it, it will be necessary to shade the plant a day or two from the heat and light by inverting a garden-pot over it, the larvæ may then be put in, and the top must be closed, either by a cover made of wire-gauze, strained over a frame and fitting close into the top, or coarse canvas may be substituted; and it will give more room for the food to grow up, if two pieces of cane or willow-twigs be tied together forming a cross, and the four ends bent down inside of the barrel, over which the canvas may be tied; the great objection to this material is, that it soon rots when exposed to the weather. Some twigs or dead bushes should be stuck round to keep off cats, &c., and the lid or covering must be opened from time to time to see what is going on. Of course such objects as the larvæ live amongst in a natural state ought to be introduced, otherwise they will frequently die for want of the proper materials to form their cocoons; moss, dead leaves, old bark, rotten wood, green turf, &c., are often required. By the method here recommended the magnificent Death's-head Moth,* which feeds upon potato-leaves whilst a caterpillar, has been bred with tolerable certainty, but these insects have almost always died after passing into the chrysalis state when fed in any other way, and I doubt not that the economy of the wire-worm might be completely developed by pursuing the same treatment.

CURCULIO PLEUROSTIGMA. The Turnip-gall Weevil.

The excrescences (fig. 16) which frequently disfigure the turnip-bulbs and are not confined to any particular variety, on being opened will be found to contain a small maggot (fig. 17), something like that which we represented in pl. F. fig. 26, but it is thicker: these galls, or knobs as they are generally called,† vary greatly in bulk, from the size of a pea to that of a large acorn; the smaller ones contain a single maggot, the larger excrescences several, as shown by the cavities laid open at fig. 17.‡ My friend Mr. Spence § having bred the Weevil from these galls, we may conclude that, soon after the turnip-bulb is formed, the impregnated female pierces a hole through the rind with her proboscis and deposits an egg in it, which shortly hatches, and the young maggot feeds upon the internal substance of the bulb: the excrescences are produced most probably, as in other similar cases, by the in-

* Curtis's Brit. Ent., fol. and pl. 147.

† Anbury is sometimes improperly applied to this malformation.

‡ I found four larvæ in one excrescence on the 9th of November.

§ Kirby and Spence's Int. to Ent., vol. i. p. 450. The roots of the charlock and cabbages are similarly affected, but by other species of the same genus.

jection of some fluid into the wound when the egg is deposited, to form a proper nidus for the embryo young, or it may be the effect of an acid secretion of the maggot. Naturalists are yet ignorant of many particulars relating to the history of this beetle, for, although the galls are visible upon the turnips from the close of summer until the opening of spring, the maggots in all probability are not many weeks in arriving at maturity. I have found them of all sizes in winter, but never met with one in the pupa state; I therefore conclude that, like the Turnip-seed weevil,* they eat their way out, and enter the earth to undergo their final transformation.

The maggots are fat and whitish (fig. 18), often of a bright flesh-colour, when they live on the swedes, wrinkled, especially on the sides: head ochreous: jaws bright nut-brown, the extremities black, as well as a minute eye on each side; when at rest and in their cells they generally lie curled up, and are not able to extend themselves and walk like the maggots of the Turnip-seed beetle, but when forcibly stretched out they are about $\frac{1}{4}$ of an inch long. After their metamorphoses in the earth a beetle is eventually produced which naturally belongs to the ORDER COLEOPTERA and the FAMILY CURCULIONIDÆ. It is designated in modern works as the

6. *Curculio* (*Ceutorhynchus*) *pleurostigma*; it is also the *Rhynchænus sulcicollis* of Gyllenhal;† the turnip-gall weevil. It is black and shining; antennæ inserted at the middle of the rostrum, which is long, slender, curved, and punctured at the base; the former are geniculated and twelve-jointed, the basal joint is long and clubbed; second and third elongated, fourth and fifth oblong, three following globose; the remainder forming an ovate-conic club; head with an impression between the eyes, and, as well as the thorax, is coarsely punctured, with short whitish depressed hairs; the latter is triangular, truncated, and narrowed before, the sides being hollowed, forming a small tubercle on each; the anterior margin reflexed, the lobes ochreous beneath; there is a broadish channel down the back, and a short groove in the breast; scutell minute and depressed; elytra semi-ovate, with ten clean-cut striæ on each; the interstices scabrous, and sparingly clothed with short whitish hairs; the apex roughish; wings two, and ample, folded and concealed beneath the cases; underside speckled with whitish ochreous scales; the pleuræ ochreous white: six legs equal, with whitish depressed hairs; thighs stout, with a small pilose tooth on the underside of each (fig. 20 f); shanks stoutish; feet four-jointed, two basal joints trigonate, third broad,

* Royal Agric. Soc. Jour., vol. iii. p. 315.

† Curtis's Guide, Gen. 345, No. 37^b; and British Entom., fol. and pl. 670.

bilobed, fourth slender, longer, and clavate, terminated by two simple claws; length, including the rostrum, $1\frac{1}{2}$ line (fig. 19).

This beetle is very similar to the turnip-seed weevil (pl. F. fig. 32); but it is black instead of grey; the wing-cases are not so rough or strongly tuberculated at their extremities, and *all* the thighs have a small tooth beneath. It is not uncommon in hedges and waste grounds, from the commencement of May to the end of August; and closely contracts all its members when alarmed, at which time it looks like a black seed. It no doubt lives in flowers, like its congeners; but no means could be devised for the destruction of this insect, which fortunately is not of much consequence, for, excepting the beauty and symmetry of the bulbs being affected, the turnips are, I apprehend, in no way injured by their presence. We may, however, mention, that partridges are very fond of the maggots, and that is undoubtedly one reason for the turnips being so attractive to those birds; they are there under cover, and run about in search of the galls, to pick out the hidden maggots, and probably others whose history I shall now proceed to relate.

ANBURY, OR FINGERS AND TOES.

That these malformations are occasioned by insects I very much doubt; yet it is unquestionably true that the bulbs of the turnips, when thus affected, are inhabited by multitudes of maggots, beetles, &c.; but then they are such as always obtain their sustenance from putrid substances, or those beetles which are carnivorous, and are attracted to such spots by the abundant supply of food which the helpless inhabitants of the diseased roots afford them. I therefore consider insects to be not the cause but the effect of anbury, although their united efforts contribute in no small degree to the more speedy dissolution of the bulbs.

The above are, I believe, two distinct diseases: but as it is very difficult to distinguish them by the published accounts of authors, I am not able to characterise them separately. The "fingers and toes" I had always supposed to be the division of the root into a number of thick appendages at the expense of the bulb; but "anbury," instead of producing radish-like appendages, is characterised by a knotted and irregular growth of the fibres. Mr. Dickson says of fingers and toes,—“It occasionally happens that turnip-plants, instead of swelling and forming bulbs, send off numerous stringy roots, which soon decay, and come to no account. It occurs most generally when the crop is sown on fresh land, and no remedy is said yet to have been discovered to prevent it. More perfect tillage, and the use of such manures as have a tendency to render such lands more mellow and friable,

may perhaps be beneficial."* Mr. Marshall, in allusion to the anbury, says that it is a large excrescence produced below the apple or bulb; and when this was just forming, and not larger than a green walnut, the anburies were as large as a goose's egg, awkward, and irregular in form, with excrescences below, not unlike races of ginger, depending from them (figs. 22 and 23). After arriving at maturity, they exhibit a putrid fermentation, and emit a most offensive scent. When the anburies are divided they are hard; but, with the assistance of a lens, veins or string-like vessels may be seen dispersed through the tumour. When turnips are affected with this disease, the tops become yellow and flag in the heat of the sun, and they are thus readily distinguished. He says it has been attributed to the land being too long continued under this green crop; but it is certain the anbury appears on land where turnips had never been grown before: he, however, considers that it proceeds from the puncture of an insect in the vessels of the tap-root, by which the course of the sap is diverted, and instead of the natural bulb an excrescence is produced. He recommends that the diseased plants should be removed as soon as possible, and the earth stirred about those that remain; and he adds that it may be wholly avoided by well preparing and richly manuring lands subject to produce anbury.† I have heard that a naked fallow is a remedy for it; but it is well known that marl is the great cure, and Norfolk marl is said to be the best. On a sandy loam in Suffolk, where anbury constantly made its appearance after the second hoeing, the application of chalk proved a certain cure, and the gentleman‡ to whom I am indebted for this information found that if, instead of growing turnips the fourth year, the crop be changed for four years more, the disease was completely eradicated. Teathing the barley-stubble which is intended for turnips will cause the anbury: if this be avoided, the good effects of marl and chalk will be felt for many years.

Whether wet or dry seasons be most favourable to anbury I cannot determine. Farmers are of opinion that the latter are the worst; and Mr. Sinclair says that when the disease has taken place, if plentiful rains ensue, the bulbs put out other roots, or rather small fibres enlarge, to supply the places of those which are wounded.§ The autumn of 1841 was wet enough, yet in Suffolk I found the turnips on a part of the coast suffering severely from anbury the beginning of November. There were in one field four different sorts of turnips growing: the long-

* Practical Agric., vol. ii. p. 666.

† Rural Economy of Norfolk, vol. ii. p. 33.

‡ Mr. J. Robinson of Henstead, Suffolk.

§ Memoirs of Caledonian Horticultural Society.

pudding (fig. 21), which seemed to be the worst affected, as the tap-root was generally completely rotten in the earth (fig. 24) : the odour was most offensive ; and on opening the wet and carious parts there were numbers of maggots in groups of five or six together, completely imbedded in the putrescent substance (fig. 25). I sometimes found as many as twenty in one root. I observed with them some minute *Acari*, both red and whitish, with quantities of small rove-beetles with their larvæ, and a few large carnivorous beetles. The branching roots were covered with simple or granulated excrescences (figs. 22 and 23), but *they* were not decaying. The Scotch yellow turnips had grown to a good size ; but the tap-root frequently produced a tumour as large as a pullet's egg. On cutting them open I found them solid, and, with the exception of a few small holes eaten here and there, which were like the erosions of the wire-worm, of which I detected one, they did not exhibit the slightest signs of any insects inhabiting them, even in an embryo state : the centre of the tumours was discoloured, and the texture perfectly fibrous or woody. The swedes, as well as the round white turnips, were but slightly affected. I likewise remember examining in August, 1841, at least a dozen young cabbage-plants with clubbed roots as large as a child's fist, but could not find a single maggot anywhere, and the tumours were sound and solid.

I think from the above evidence it is pretty clear that certain conditions of the soil, induced probably by the repetition of certain crops, and not insects, are the cause of anbury :* the enlargement of the lateral roots, which become woody, stops the flow of sap to the bulb ; it consequently ceases to draw nourishment from the soil, when it dies and rots in the earth, and becomes a fit nidus for a variety of insects. With regard to fingers and toes, if that disease be the malformation I take it for, it arises possibly from the land not having been sufficiently prepared for the turnip crop ; but this is an opinion which I venture with great deference to offer for the consideration of the practical cultivator.

It will now be necessary to give the histories of the insects alluded to which inhabit the anbury. The most important of them is the maggot of a delicate gnat, which, as I have already stated, lives in small families in the putrid and moist portions of the bulb (fig. 25). These larvæ are slender, cylindrical, shining, and pale yellow (fig. 26) : they taper gradually to the head, which

* If cabbages be planted, or the seed sown, for several years following, upon the same land, the roots get knotty, and the heads become smaller ; but if cultivators would procure strong and healthy plants from a market-garden, instead of sowing their own seed, it would do much towards obviating this mischievous disease.

is very pointed, with two black lines on the crown, and two horny spines or jaws at the mouth: the body is composed of about twelve segments, thickening towards the tail, which is blunt and rounded, with two brown spots, being the tips of two tubercles: they are about 5 lines, or not quite $\frac{1}{2}$ an inch long (fig. 26 p). When full-grown in November, I placed them, with the diseased root they inhabited, in a garden-pot with mould, and in the following April a great number of female gnats had hatched, but were all dead; they therefore must have come forth at an earlier period: the empty pupæ-cases were lying about, but I could not find one unhatched, which I am led to regret, because even De Geer was unacquainted with the economy of this insect; a figure, therefore, of the pupa would have been interesting. The empty cases were pale dirty ochreous, exhibiting the forms of the different members of the imago; they were a little arched, the tail was pointed, with two parallel spines at the tip, and two short-pointed teeth above them. The gnats are often seen resting upon the inside of our windows in the winter, especially after the breaking up of frosts, and in calm days they fly in troops in fields and gardens, dancing together in the air without separating, and during the severest frosts these fragile flies, which are so delicate that one would imagine a breath, much more a northern blast, would annihilate them, may be found standing upon the sides of walls in damp gardens as unaffected apparently as in the finest days of spring. Six species have been found in England;* and one of them has been bred from putrid *Fungi* by Mr. Haliday. These gnats belong to the ORDER DIPTERA, and to the FAMILY TIPULIDÆ; they form a GENUS called by Meigen TRICHCOCERA: the species infesting the turnips is named by the Baron De Geer

7. *T. hiemalis*, the Winter turnip-gnat (fig. 27). The males are smaller than the females, and are distinguished by the structure of the tail: they are of an ash-colour; the head is small and globular, with two lateral black eyes; the neck is slender; the mouth forms a little beak; the feelers are distinct, incurved, and five-jointed; the horns are longish, pubescent, setaceous, being very slender at the tips, composed of many joints, the two basal globose, third the longest, the remainder elongated: thorax oval, cinereous, with four fuscous stripes; body cylindric, pubescent, the apex obtuse in the male, with two incurved appendages, forming a pair of forceps; more conical in the female; with two parallel black hooks bent down like a claw at the apex, and forming the ovipositor; wings incumbent in repose, ample, much longer than the body, glassy, iridescent, slightly stained with yellow, having numerous longitudinal nervures, forming one dis-

* Curtis's Guide, Gen. 1165.

coidal and seven posterior cells; balancers pale, the club fuscous; six legs long, very slender, and pubescent; thighs long, shanks longer, especially the hinder; feet long, five-jointed, basal joint very long, fourth and fifth elliptical, the latter furnished with two minute claws and suckers: length, $3\frac{1}{2}$ lines; expanse of wings, $6\frac{3}{4}$.

The *Acari*, or mites found with the maggots, were the size of a grain of sand; most of them were reddish-brown, but some, which were smaller and younger, were whitish: the two feelers and eight legs were hairy and pale ochreous. They probably had been introduced by the large rove-beetles, which are often infested by these parasites; and they may attack the various larvæ inhabiting the turnips, and perhaps destroy the eggs from which they are produced; but these are only conjectures.* On another occasion I examined some diseased and enlarged cabbage-stalks at the end of May, and on opening one of the galls, which was soft, I found it filled with a white acarus; the four hinder legs were much smaller than the others, and the tips were furnished with a single claw.

There is frequently a variety of rove-beetles in rotten turnips, principally of the genera *Aleochara*† and *Oxytelus*;‡ their habits are similar, being constantly found in decomposing animal and vegetable substances: when turnips have what is termed a "grubbed" appearance, it has been attributed to the larvæ of these little beetles; and Sir Joseph Banks stated that forty or fifty of the larvæ of a *Staphylinus* had been discovered in October just below the leaves in a single bulb.§ I also received specimens of the above genera from the Rev. T. H. Scott, of Whitfield Rectory, near Heydon Bridge, Northumberland. They made their appearance about the beginning of July; and on hoeing the turnips they were observed about the roots, and were gnawing them. This is remarkable; for two of these beetles lived three months upon maggots found in some turnips.|| It is not the turnips alone that are infested by this tribe of insects; for this, or a similar larva to the above, sometimes does great mischief to wheat-crops, as we shall show in a future communication. On digging up some old turnips in the garden the end of last March, I found several of the larvæ (fig. 28) in the rotten bulbs, with eight or ten specimens of a small rove-beetle, which I doubt not

* In a recent number of the Trans. of the Ent. Soc. it is stated that the *Aleochara* themselves feed upon the *Acari*. Vide vol. iii. p. 111.

† Curtis's Guide, Gen. 221; and Brit. Ent., *Homalota* and *Phytosus*, pl. and fol. 514 and 718.

‡ Ibid., Gen. 216.

§ Kirby and Spence's Introd. to Ent., vol. i. p. 186.

|| Gardener's Mag. vol. viii. p. 323.

had been bred from them. The horns of the larvæ appear furcated at the second joint, from the bristle being incrassated, and, I believe, jointed: the jaws are strong, curved, and acute (*q*); there are five minute eyes on each side of the head, which is reddish-brown, with a semicircular line of the same colour on the first thoracic segment. The body is white, shaded with ochre, the intestines shining through the back behind: at the tail is a thickish foot, and above it two jointed tapering tails, all ochreous: the six pectoral legs are of the same colour: length, 2 lines (*k*). The beetles of which these are the larvæ are COLEOPTEROUS, of the FAMILY STAPHYLINIDÆ, and this group forms the GENUS OXYTELUS of Gravenhorst; the species is named by the same author

8. *O. sculpturatus*, the Sculptured rove-beetle, from the deep channels upon the thorax: it is depressed, pitchy black, and shining, excessively, thickly, and minutely punctured, and striated, with large points scattered over the surface: horns remote, short, hairy, thickened considerably at the extremity, eleven-jointed, basal joint long, forming an angle with the second, which is small and pear-shaped; third and fourth minute globose, the remainder broader than long, being somewhat cup-shaped, excepting the terminal joint, which is the largest and ovate-conic; mouth brown; jaws strong, arcuated, pointed, with a tooth on the inside: feelers visible, maxillary four-jointed, labial three-jointed, the terminal joint slender and often ferruginous: head frequently as broad as the thorax, transverse-ovate, flattened between the eyes, with an elevated ridge near each, and two short channels on the nose, with an obscure one at the base: thorax transverse, the lateral margins smooth, three broad channels down the back, the central one deepest; scutel invisible; elytra nearly quadrate, often pitchy or brown, and rarely testaceous; wings very ample, transparent, and folded under the wing-cases in repose: body very glossy, rather short, linear, the sides margined, apex pointed; six legs, short and ochreous; the thighs stoutish; shanks spiny outside: the first pair notched externally at the apex; feet rather long, slender, and triarticulate; basal joints minute, third long and clavate; claws long, slender, and acute: length from $1\frac{1}{4}$ to $1\frac{3}{4}$ line; expanse of wings, from $\frac{1}{4}$ of an inch to 4 lines (fig. 29).

It is impossible to turn over any dung which has been dropped only a few hours without finding it taken possession of by insects, and amongst them the *O. sculpturatus* and *O. rugosus** will generally be recognised: when such deposits are a few days old they often swarm with these and other *Coleoptera*. They are able

* Numbers of this species were discovered in the clubbed roots of brocoli, in the middle of September, in a garden in Surrey.

to fly well ; and towards sunset multitudes are roving about, and apparently enjoying, on the wing, the decline of day. Indeed they may be said to be found everywhere, and at all seasons. They are able to emit an acid, or some acrid liquor, from the mouth when irritated, which causes great pain when they fly into our eyes ; and it lasts until the poison becomes diluted by tears from the lachrymal ducts.

Lastly, we come to several two-winged flies, which, by depositing their eggs either in the crown of the turnip or close to the young bulb, cause the destruction of that plant. My attention was first called to this enemy of the farmer a few years since by Edward Bennet, Esq., of Rougham Old Hall, in Suffolk. We found many of the turnip-plants in that parish which had a maggot either in the young crown or just inside, at the base of the tap-root, which was indicated by a yellow tint on the leaves, the flagging of the plants in the heat of the day, and their dropping off : this was during the first week of August ; in a few days after the maggots changed to pupæ, and in about three weeks two male flies and one female hatched from them. The Rev. C. Clarke also showed me some white maggots at the roots of the cabbages about the same period, which destroyed his plants earlier in the year, by eating off the fibrous roots and excoriating the stem below the surface. When I saw them they were living under the rind of the stem ; and he informed me that the same or a similar maggot sometimes does great mischief to the Swedish turnips. These maggots were identical with broods reared from cabbages by another friend in Surrey ; but in that instance the maggots were feeding the beginning of June, and the flies emerged the end of the same month.

These maggots are somewhat like those of the flesh-fly, but smaller : they are yellowish-white and shining, composed of eleven visible rings, tapering very much to the head, which is pointed, and terminated by two black horny claws, and there is a dark spot on the first segment : the rump is the thickest, and cut off abruptly, with two brown tubercles in the centre, and several short teeth on the lower margin : when full-grown they are about 4 lines long (fig. 30) ; they then change below the surface of the earth to reddish-brown pupæ (fig. 31) : these are cylindrical and elliptical, with a few black tubercles on the head, and short spines on the rump, similar to those on the maggots ; for these brown cases are, in fact, their indurated skins, which are not cast off in the penultimate transformation, as they are in the caterpillars of butterflies and many other larvæ ; neither do maggots change their skins as they grow, which is unnecessary, as they are extremely thin, and stretch so readily, that as the animal increases in bulk so does its skin expand. In three weeks at the utmost

the flies hatch and crawl out of the earth, with their little wings crumpled up, and climbing up the side of a clod or any perpendicular surface before they get dry, they expand and become the proper organs of flight. These, as well as the following species of flies, are comprehended in the ORDER DIPTERA, and form the FAMILY MUSCIDÆ: the GENUS comprising them is called ANTHOMYIA by Meigen,* and the species, from its attacking the cabbages, is named by Bouché†—

9. *A. Brassicæ*, the Cabbage-fly. The sexes of this fly differ materially in aspect: the *male* is ashy grey, very bristly; the large compound eyes nearly meet on the crown of the head, which is hemispherical: there are three minute eyes at the base of the crown; the face is silvery-gray, almost white in some lights, with a long black streak on the forehead, pointed behind, below which are the black and triarticulate horns, the basal joint of which is small, the second large, the third the largest and oval, with a biarticulate pubescent bristle on the back, the basal joint being very minute: thorax oblong, the sides whitish, with three faint interrupted stripes down the back; body shining gray, rather small and elliptical, tapering to the apex, with a black stripe down the back; the edges of the segments and the region of the scutel black also: two wings incumbent in repose, ample, transparent, iridescent, the longitudinal nervures reaching the posterior margin, with two transverse ones towards the disc; balancers ochreous; six legs black and spiny; thighs and shanks simple; feet five-jointed, terminated by two little claws, and two largish pale leathery lobes (fig. 32). The *female* is of a uniform ashy-grey, excepting the silvery-white face and pale sides of the thorax: the eyes are remote, with a broad black stripe between them, shading into chestnut-colour in front: the abdomen is stouter, and conical at the apex, and the wings have an ochreous tinge at the base (fig. 33): $\frac{3}{4}$ length, nearly $\frac{1}{4}$ of an inch; expanse of wings, almost $\frac{1}{2}$ an inch.

These flies are on the wing the whole of summer, and there are consequently several generations of the maggots which are for many months eating passages in the stalks and roots of the cabbage and turnip tribes, thus causing them to become rotten as soon as they are subjected to wet and frost. Many of the flies no doubt live through the winter, secreted in holes and crevices, and some of the pupæ do not hatch until the spring: in one instance the maggots and pupæ were taken from the roots at the same time, the 19th of June, and the flies began to hatch on the

* Curtis's Guide, Gen. 1287.

† Naturg. der Garten-Insecten, p. 131.

‡ For the structure of the mouth, dissections, &c., consult Curtis's Brit. Ent., pl. and fol. 768, *Hydrotæa*, an allied genus.

27th. On pulling up the stalks of some cabbages recently cut, I found the roots enlarged, lumpy, and carious; and on opening them they were hollow, with the maggots of the cabbage-fly full-grown in cavities, several of which hatched in May, 1841, together with another fly.*

Two other species of similar flies are noticed by Bouché as attacking these crops: one he calls, after Meigen,

10. *Anthomyia gnava*. Horns pubescent; eyes not hairy; legs black. *Male* with a black thorax; body linear, cinereous, fasciated with testaceous and black dorsal spots. *Female* cinereous; body with a blackish dorsal line, dilated at the base: length 3 lines.†

The larvæ of this fly are found on the Continent during the autumn in turnips, eating cavities in the bulbs; but they have not yet been observed in England. The other species described in Bouché's work is likewise unknown to me; but as it will, in all probability, soon be detected in this country, I will give a short description of the insect, which bears the name of .

11. *Anthomyia trimaculata*: it is like *A. carnaria* of Meigen, but smaller; light-grey, varying with the light to white; thorax with four black interrupted dorsal stripes; scutellum with three brown spots; legs black; abdomen chequered with brown, and a broad black dorsal stripe. The *female* is altogether paler, with the apex of the thighs and tibiæ reddish-brown: length, $3\frac{1}{2}$ lines. The maggots of this are similar to the others, and they are five lines long: the pupa also is scarcely to be distinguished from them: it is 3 lines long.

The maggots are found in summer and autumn in company with *A. Brassicæ*, in cabbage-roots, which they destroy. They remain pupæ three or four weeks, and the latter generations winter in the earth under that form, and produce flies in the spring: the female flies are tolerably abundant in fields and gardens.

The last species I have to record was sent to me from Northumberland by Mr. T. H. Scott, the 21st July, 1841. He says, "My servant, who has been hoeing the turnips, tells me these larvæ are always found in the roots, and not in the surrounding soil. Since the late rains they have decreased, and it was with some difficulty the few I transmit could be found in two acres." They were taken out of the roots, several of which were sent (fig. 34) to show the mischief done by the maggots and the little rove-beetles: precisely at the same period of the year, on cutting

* *Euemerus æneus*. Vide Gardener's Chron., vol. ii. p. 252; and Curtis's Brit. Ent., pl. and fol. 749.

† Meigen's Syst. Besch., vol. v. p. 164, No. 142.

a turnip in halves from the garden, I found a maggot inside quite as large as Mr. Scott's.

The above maggots were similar in form to those of *A. Brassicæ*, but of a yellowish-ochre colour. The head was armed with two black hooks; and at the extremity of the back was a green stripe, from the intestines shining through: the rump was truncated and furnished with two brown projecting spiracles, and the margin surrounded with small teeth, largest below (figs. 35 and 36). I put them with a turnip-root into a flower-pot, and the following April I found four of them in the pupa state, and buried deep in the earth: these pupæ were also like those of *A. Brassicæ*, but of a paler colour, being lurid ochreous. On the 25th April I bred a male fly, and soon after two females: they proved to be a Linnæan species of *Musca*, the larvæ of which will devour a great variety of roots, and inhabit dung by thousands in the summer, according to Bouché: the fly is called

12. *Anthomyia Radicum*, the Root-eating fly. It is similar in size and form to *A. Brassicæ* (figs. 32 and 33); but the *male* has an ochreous face, reflecting satiny white; the stripe on the forehead is rusty; the thorax is black, with three darker stripes; the sides are grey; scutell blackish; abdomen slender, linear, shining grey, with a broad black dorsal stripe; the incisures are black also: wings, balancers, and legs as in *A. Brassicæ*. *Female* still more like that species; but there are three fuscous stripes on the thorax, and in certain lights a slender dark line down the back of the abdomen: length, $2\frac{1}{2}$ lines.

It is remarked by Bouché that the larva of a four-winged fly called *Alysia Manducator* lives in the pupæ of several flies allied to those above described: it makes a thin yellow case inside of the pupa, and comes forth in spring and summer, when it is not unfrequently seen in and about decayed turnip-roots and dead animals, in a state of decomposition. From these observations it may be inferred that it is a general parasite of such flies, and that those maggots which infest the turnips and cabbages do not escape its vigilance. I will therefore add a short description of this useful insect. It is HYMENOPTEROUS, of the FAMILY ICHNEUMONES ADSCITI; and is called by Panzer,

13. *Alysia Manducator*, from its gaping teeth or jaws: it is black, and very shining; the tridentate jaws are chestnut; antennæ rather long, slender, pubescent, composed of numerous joints; postscutell and broad flat base of abdomen rugose, the latter oval, with a projecting ovipositor in the female: four wings with the stigma and nervures pitchy; legs bright rust colour; feet dusky: length, $\frac{1}{4}$ of an inch; expanse, $\frac{1}{2}$ an inch.*

* Vide Curtis's Brit. Ent., fol. and pl. 141; and Guide, Gen. 558, No. 5.

With this exception I know of no parasitic insects to keep these turnip-destroying maggots in check: I shall therefore now conclude this investigation of their habits and economy by appending such remedies as have fallen in my way. It often happens that very good specifics which may be successfully employed in the garden cannot conveniently be extended to the field: such, I fear, is the following remedy proposed by Bouché. He says that where whole fields of cabbages have fallen a sacrifice to the destructive maggots, that the crops are now completely preserved by dipping the roots, as they are transplanted, into oil or ley of ashes. One of the best modes of diminishing their numbers, I doubt not, is to pull up and remove infected plants on the first symptoms of the presence of insects at their roots, which is instantly detected by the drooping of the leaves in the sunshine, those of the cabbages turning of a faint lead colour, and the turnip-tops becoming yellow. When this is the case, they should be immediately carried away and burnt, and brine or ley of ashes may be at once poured into the holes from whence the plants have been drawn, to destroy any insects left behind. In other instances, where the maggots have made great havoc with the cabbages, cauliflowers, and brocoli, gardeners have collected large quantities of the brown pupæ from the roots with the hope of checking their increase; and as the transformations of the insects are in rapid succession, it must have a good effect by giving the succeeding crops a better chance of escaping the fate of those which preceded them.

Mr. Sinclair, in allusion to the turnip-galls, says, "Combinations of salt and lime were evidently the most effectual, as no instance occurred of the bulb being affected below the surface of the soil. That portion, however, of it which was above the surface was affected with galls, the same as in the bulbs grown on soils of the same nature, to which no application of manure had been applied. On a space of the same soil, to which salt simply had been applied the preceding spring, and from which time the soil remained fallow, the crop was good. One plant in ten, however, was affected with the disease below the surface, as well as above it. The salt in this instance had been applied at the rate of 86 bushels per acre, and mixed with the surface 4 inches deep: it was applied the first week of May, 1818. On one portion of it barley and turnips were sown, but they did not vegetate, the dose being too great. The season following, however, the crop was good." It was observed that the same dressing on a clayey loam did not prevent the galls from forming. I apprehend, however, that the lime and salt would certainly destroy the different maggots that we have described, but not the weevils: for it must be remembered that the author of the galls is a hard beetle, and its

embryo young live under the rind, secure at that period from any outward applications. Mr. Sinclair goes on to say that "mixing the lime and salt with the soil previously to sowing the seed, or applying it to the surface after sowing, proved best; for when lime and salt are mixed and deposited with the seed, vegetation is retarded from 2 to 12 days, and more, beyond the natural period. This fact was proved on the seed of 8 different species of plants, sown in 4 different kinds of soil. They modify, but are not a specific remedy for this disease. Seeds from roots perfectly free, sown on land that never was sown with turnip-seed before, produced in both instances bulbs more or less affected."*

Another contributor to the Gardener's Magazine says the attacks of insects causing the malformations in turnips can only be averted by making the plants offensive to the parent-fly; and this, it has been lately discovered, can be done by incorporating with the soil soap-boilers' waste, or any other substance of similar alkaline quality. Mr. Major recommends the plants to be watered with a mixture of 1 gallon of soap-suds to 4 quarts of gas-water, or, in lieu of the latter, 2 quarts of gas-tar; either will do, as the only use of the mixture is to create an offensive smell. Mr. T. Smith says he is satisfied, from six years' experience, that the refuse of a charcoal-pit, spread $\frac{1}{2}$ an inch thick before sowing the seed, and merely scuffled in with the point of a spade, so as to mix the top soil and charcoal-dust together, is a remedy for the grub and mouldiness in onions; † and it effectually prevents the clubbing in the roots of cabbages and cauliflowers.

Few of these remedies will, I fear, be of much service on a large scale: the farmer must therefore encourage the natural enemies of these pests, and remember that rooks, sea-gulls, magpies, and partridges, as well as many species of small birds, are eminently useful in cleansing the soil from such troublesome insects. If poultry be turned into the field they require attention, otherwise they are apt to scratch up the soil. My own opinion is, that nothing can be more likely to encourage the maggots of the cabbage and turnip-flies ‡ than fresh dung, in which it seems they luxuriate; and, such being the case, by spreading it in a raw state, an entire field may at once be inoculated with the disease.

* Memoirs of Caledonian Hort. Society.

† *Anthomyia ceparum* (Gardener's Chron., vol. i. p. 396): the maggots of this fly are so similar in appearance and economy to those of the turnip, that many gardeners take them to be the same species.—Vide Major's Treatise on Insects, p. 165.

‡ We have on a former occasion animadverted upon the impropriety of calling the *Altica Nemorum* by the name of "turnip-fly;" which is here exemplified, for the above insect is truly the turnip-fly; and the *A. Nemorum*, the turnip-flea or black-jack, is as undoubtedly a beetle.

Summary of the foregoing Report.

Surface-grubs, in 1818, 1826, 1827, and 1836, were very numerous and destructive to turnip-crops; so much so, that prizes were offered for the history of these caterpillars, and the remedies for their destruction.

The Cabbage-moth flies by night in May, June, and July: the female lays her eggs upon the leaves of cabbages, turnips, &c.

The *caterpillars* are *universal feeders*, living upon an astonishing variety of plants, during July, August, September, and October: the garden suffers most from their attacks, and cabbages have their hearts quite riddled and defiled by them.

They sometimes *live through mild winters*, concealed either amongst rubbish on the surface or buried in the *earth*, where they change to *chrysalides*.

The most effectual *remedy* is to *search* for them *at night*, when they come out to feed, and to look carefully *beneath the leaves by day*.

The great yellow-underwing moth is abundant in hay-fields, hedges, and gardens, in June and July: it is the parent of a large *surface-grub*, which feeds upon the *roots and leaves of turnips* in the autumn: it lives through the winter, sometimes under the turf in meadows, &c., and can resist frost. In April it changes to a large brown *chrysalis*, in the soil, enclosed in an earthen case.

In a bed of *onions*, which this caterpillar had *destroyed*, 47 were found in an area of less than 25 feet.

The heart and dart moth is found plentifully in June, in fields, gardens, &c.: it is the parent of a most pernicious surface-grub, which destroys immense quantities of turnips, at every stage, either by separating the crown from the root, or by eating into the more matured bulb.

The surface-caterpillar attacked the *swedes* in August: it was abundant in November, and no doubt lived through the winter.

The common dart-moth flies in multitudes in June and July, and is supposed to lay its eggs in the earth, which produce surface-caterpillars more destructive, if possible, than any of the others.

The *eggs* hatch in autumn, and the surface-grubs live through the winter: they are either feeding a long period, or there are two broods annually.

Mangold-wurzel had the young roots eaten through by them in June: they also attacked the potato-shoots.

Abundant in August, 1841, at the *roots of swedes*, in Surrey; and in multitudes at Farnham in September, 1839. During the same months they abounded in Suffolk, in 1835, and were equally numerous there in November, 1841.

The western countries of Europe have been threatened with *famine* from their destroying the *corn*, by devouring the roots, especially of that sown in autumn.

The gardener suffers from their attacks, for they will feed upon the *roots* of various *vegetables* and *flowers*.

As they are forced to feed upon the *roots of grass and weeds*, in the summer, in fields lying fallow or recently sown, it is most essential to keep the land clean whilst at rest.

They pass the *winter* underground, in earthen cells, and come forth to feed again in the early *spring*.

In May or June they enter the earth to change to *chrysalides*, in which they remain about a month.

Mr. Le Keux found these surface-grubs concealed, by day, in *burrows* 2 or 3 inches deep, into which they draw *detached leaves*.

Salt and water poured over a turnip-plant, at the rate of a $\frac{1}{4}$ oz. of salt to 1 quart of water, drove the surface-grub away, but it proceeded to another 6 yards off: they can travel well and expeditiously, especially at night, when the ground is damp. During 10 days other plants were washed with that solution, and were thus preserved; but, when discontinued, they shared the fate of the others.

Children might readily *pick* them from the roots with a sharpened flattish stick, or an oyster-knife.

Serious attacks of these surface-caterpillars are often to be attributed to the *destruction* of the *roots*.

Another, and larger, *Surface-caterpillar* feeds upon *turnip-roots*, and eats off the *crowns*: these larvæ also injure the roots of *cabbages*, and will devour the *leaves*. They bury themselves very deep; and are 2 inches long in the autumn: they were in the chrysalis state in March.

The *surface-grubs* are at work almost all the year: in the *summer* they destroy the young plants by eating off the roots near the crown; in the *autumn* and mild *winters* they eat large cavities in the bulb, which get filled with dirt, and are not good for stock; the *weight* is also *reduced*, and they more readily *decay* from wet and frost.

Harrowing, ploughing, and working the soil afford the only chance of destroying the *eggs*, and probably the *chrysalides*.

Insects thrive best on *neglected* and slovenly cultivated *lands*.

Night-time is the best for applying *liquids* and *powders* to destroy the surface-caterpillars.

Tobacco-water will kill them, if it come in *contact* with their *skins*.

Hand-picking by night is universally recommended on the Continent.

Dry soot, spread an inch thick, and dug in, is said never to fail. *Cabbage-plants* may be preserved by laying some round the stems.

Lime also, employed in the same way, is a protection; and if *quick-lime* were dusted over the turnips, after rain in the evening, it would destroy the surface-grubs.

Poultry and *ducks* would be serviceable, if turned into the field when *ploughing*.

In *gardens*, planting *cabbages*, &c., round a seed-bed is a good *decoy*: the roots may be daily searched, and the larvæ destroyed.

When a *plant dies*, dig it up immediately, and the larvæ will be found.

Soap and water poured round the plants will compel the surface-grubs to come out of their burrows, when they must be directly picked up.

Pigs, perhaps, may be employed late in the year, where the surface-grubs are swarming, and ten or twelve round one bulb.

No *outward applications* will affect the *chrysalides*, which lie entombed in the earth.

Fires at night, to attract the moths, of little service, as the *females* are not caught by such means.

As regards *corn-crops*, *late sowing* would prove the best; and June and July the most improper for *turnips*, where the surface-caterpillars are numerous.

Spring-corn most likely to suffer from their attacks.

Soils made *strong and warm* by horse-dung manure most infested, from the *eggs* hatching more rapidly.

Steeping the *seeds* in bitter extracts mixed with salt or nitrates useless; but *ammonia* would annoy the surface-grubs, if applied in sufficient quantity to the soil; and liquid manure would therefore be beneficial.

Slaked lime mixed with seed-wheat, and then heated and sown together, has been recommended.

Scattering ashes before and after sowing might secure the crops.

Sticking inverted young *fir-trees* in the fields protects crops, it is said in Sweden, from seed-eating caterpillars.

Hemp, sown round a field, will attract small birds, which will also feed upon the insects.

No *parasitic insects* hitherto detected to check the increase of the surface-caterpillars.

Directions for rearing surface-caterpillars, and breeding the moths from them.

The *turnip-gall weevil* is produced from the excrescences on turnip-bulbs.

These *galls* contain from one to four *maggots*, which feed upon

the *bulb*; the galls are probably caused by some fluid from the parent-beetle.

These galls are formed in *summer*, and increase through the *winter*.

The *maggots* most probably change to *pupæ* in the earth.

The *turnip-gall beetles* are not uncommon in hedges, &c., in spring and summer.

Partridges pick out these maggots, and are very fond of them.

Anbury, I think, is not caused by insects; but the disease affords a suitable pabulum for many species.

Anbury and *fingers and toes* two distinct diseases? the former with knotted roots, the latter more forked.

Mr. Dickson's observations on *fingers and toes*.

Mr. Marshall's description of *anbury*: he considers it caused by the puncture of an insect.

A naked fallow recommended as a remedy.

Marl or *chalk* the most certain and lasting cure.

Teathing the barley-stubble will cause anbury.

Whether *wet or dry seasons* are most favourable to anbury seems to be doubtful.

The *long pudding-turnip* the most, the *swedes* and *rounds* the least diseased.

In the tap-root, *maggots*, *mites*, *rove-beetles*, &c., were living.

The *knots* on the roots *solid*, and in no instance containing insects.

Certain conditions of the *soil*, and *not insects*, cause anbury.

The *maggots* inhabiting the anbury lived through part of the winter, and produced the "*Winter turnip-gnat*" very early in the spring.

The *mites* may feed upon the larvæ, or the eggs, of the flies, &c., deposited in the anbury, or they might have been introduced by the larger beetles which they infest.

Rove-beetles, called *Aleochara* and *Oxytelus*, inhabit decaying turnips in multitudes.

They are supposed to *nibble* and injure the *roots* of the young *turnips*, and they will also feed upon *maggots*: their own larvæ are found with them.

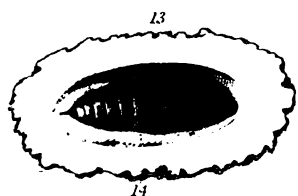
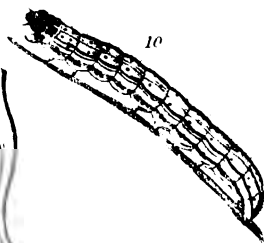
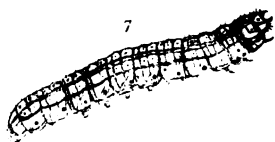
The *Oxyteli* are found everywhere, and inhabit *dung* in immense quantities.

Maggots found in August, and earlier, in the *crown*, or just in the base of the tap-root, which do great mischief.

They change to *pupæ* in the *earth*, and in three weeks they produce flies, called the *cabbage-fly*, which live through the summer.

Two species, of similar habits, are known upon the *Continent*;





G

11 12 13 14

and a fourth I bred from other maggots, which had injured the young turnip-roots.

They are exceedingly mischievous, as they will feed upon a great variety of roots; and inhabit dung in thousands.

They changed to a fly, called the *root-eating fly*.

A very useful parasitic fly lives upon these maggots.

Dipping the roots in oil or ley of ashes will preserve cabbages from the maggots.

As soon as plants droop, pull them up and burn them; and then pour brine or ley of ashes into the holes, and it will kill all that remain.

The pupæ may be collected from the roots, in gardens at least, with great advantage.

A dressing of lime and salt would kill the maggots, but it will not prevent turnip-galls from appearing.

The lime and salt should be mixed with the soil previously to sowing the seed, as they otherwise retard vegetation.

Soap-boiler's waste, and other alkalies, incorporated with the soil, will kill the maggots.

Soapsuds and gas-water, or gas-tar, will keep the flies from depositing eggs.

Refuse of charcoal, scuffled into the soil, prevented the same disease in onions, and the clubbing of cabbages, &c.

Rooks, sea-gulls, magpies, partridges, &c., most useful in securing crops from the attacks of insects.

Raw-dung, especially horse-dung, encourages the maggots, and should therefore never be spread in that state, not even in small quantities.

EXPLANATION OF THE PLATES.

Fig. 1. *Noctua Brassicæ*, the cabbage-moth.

Fig. 2. Caterpillar of the same.

Fig. 3. Ditto, a green variety.

Fig. 4. *Noctua pronuba*, the great yellow underwing moth.

Fig. 5. Caterpillar of ditto.

Fig. 6. *Noctua exclamationis*, the heart and dart moth at rest.

Fig. 7. Caterpillar of ditto.

Fig. 8. A turnip-crown with the root eaten off.

Fig. 9. *Noctua Segetum*, the common dart-moth at rest.

Fig. 10. Caterpillar of ditto.

Fig. 11. A young mangel-wurzel plant with the root eaten through by the last surface-caterpillar.

a The base of the root.

b The terminal portion.

Fig. 12. A caterpillar, or surface-grub: the moth it would change to not ascertained.

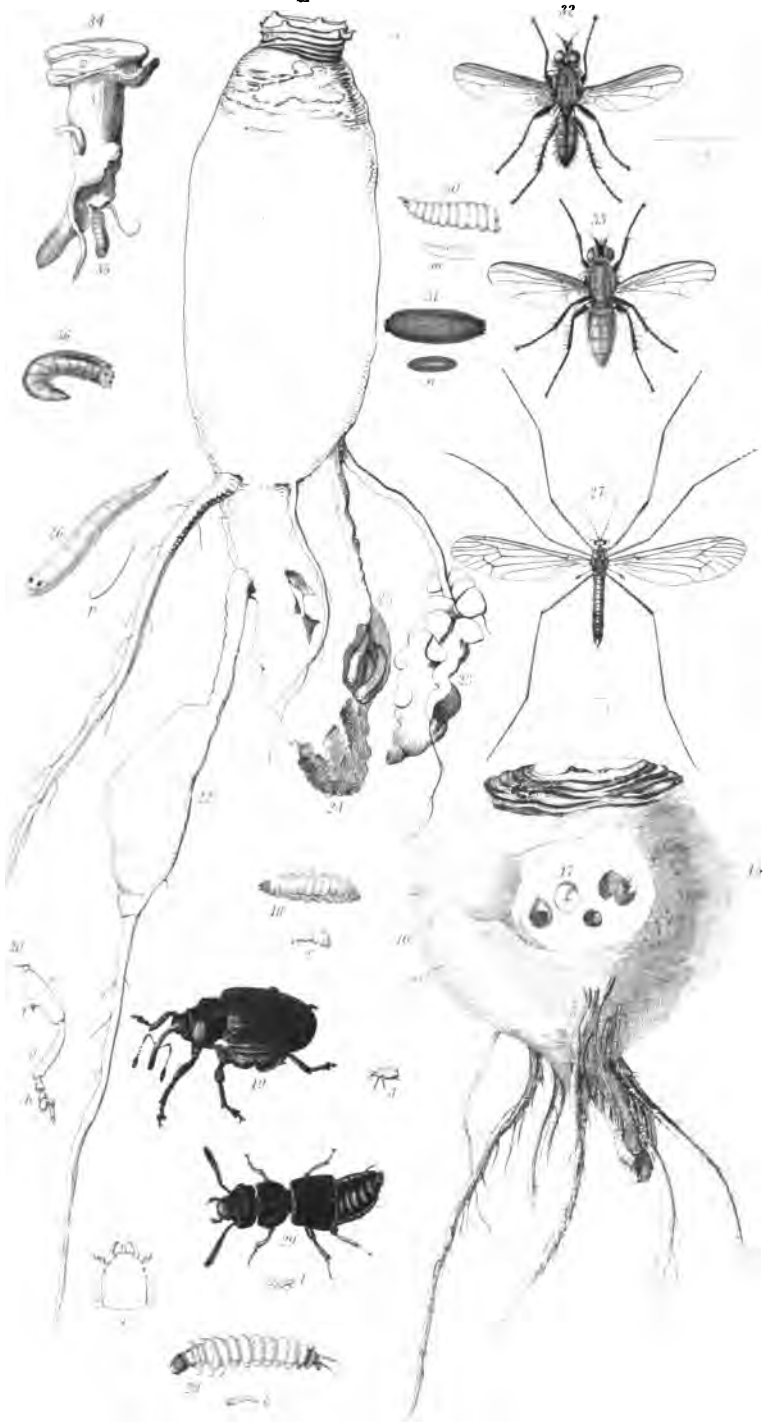
138 *Observations on Insects affecting the Turnip-Crops.*

- Fig. 13. The case of earth which the surface-grub forms in the ground.
Fig. 14. The chrysalis contained in it.
Fig. 15. A turnip-bulb affected by galls.
Fig. 16. A small gall, or knob, unopened.
Fig. 17. A large one cut open, showing several cavities in which the maggots had fed; one of them remaining.
Fig. 18.* The same maggot taken out.
 c The natural dimensions.
Fig. 19.* The weevil which causes these galls.
 d The natural size.
Fig. 20.* The fore-leg of the turnip-gall weevil.
 e The *femur*, or thigh.
 f The tooth.
 g The *tibia*, or shank.
 h The *tarsus*, or foot.
Fig. 21. A turnip affected by anbury.
Fig. 22. A solid excrescence formed on one of the fibres.
Fig. 23. Ditto, more granulated.
Fig. 24. The rotten tap-root.
Fig. 25. Maggots living in ditto.
Fig. 26.* Ditto, taken out and magnified.
 p The natural size.
Fig. 27.* The winter-turnip gnat.
 i The natural dimensions.
Fig. 28.* The larva of the sculptured rove-beetle.
 k The natural size.
 *q** The head, showing the jaws, horns, &c.
Fig. 29.* The sculptured rove-beetle.
 l The natural length.
Fig. 30.* A maggot of the turnip-root fly.
 m The natural size.
Fig. 31.* Pupa of the same.
 n The natural size.
Fig. 32.* The male turnip-root fly.
Fig. 33.* The female ditto.
 o The natural dimensions of the sexes.
Fig. 34. A young turnip-root eaten by maggots and rove-beetles.
Fig. 35. One of the maggots.
Fig. 36.* The same magnified.

Obs. All the figures are drawn from nature, excepting No. 2; and the above numbers with a * attached indicate that the objects referred to are represented much larger than life.

London, Oct., 1842.

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X.—On Modes of Comparing the Nutritive Values of different Crops. By W. H. HYETT.

It is well known that different esculent roots, and probably different varieties of the same root, differ in their weight with reference to equal bulks; and there are some reasons for thinking that this difference (called their specific gravity) might,* *when ascertained*, afford an easy, though somewhat rough, method of estimating some of their relative powers of nourishment. Water, with sugar, starch, gluten, and albumen, are the constituents which make up, with trifling exceptions, the mass of our common agricultural roots. In 1000 parts of the potato more than 700 are water. About 274 have been found to be composed of the above-named vegetable principles, said to be positively nutritious—the remainder consisting of a very trifling amount of soluble salts, and still less of insoluble earths and oxides. In the same manner 1000 parts of mangold wurzel, of swedes, and of turnips, give by analysis respectively 139, 64, and 42, of these nutritive ingredients—the large proportion of the remainder being water, with which all the pores of a healthy and perfect root, when fresh taken from the ground, seem to be filled. Though it must perhaps be admitted that the elements of water, as food, have some effect on the animal economy, it is the other constituent principles of vege-

* The published tables of specific gravities enumerate a great variety of stones, metals, woods, earths, salts, acids, oils, gases, wines, &c., with many of which the specific gravity is used as the best practical measure of their various qualities. The amount of nutritious ingredient contained in milk and wort is measured by an instrument expressly made to take the specific gravity. But in none of these lists can I discover that any of our agricultural productions are noticed; nor in our best and most recent works on these subjects, such as Thomson's 'Vegetable Chemistry,' where 35 of the "principal roots employed in medicine and the arts" are treated of, can I find the general proportions of the proximate principles of any of our commonest agricultural roots, with the exception of the potato, and yet these principles are supposed to contain the primary essentials of all animal nourishment. It is true the proportion of sugar in beet, and the peculiar proximate composition of carrot juice, is given chiefly from the elaborate investigations of Eynhoff, but no notice whatever is taken of the turnip, swede, nor (except that of beet) of any of the varieties of mangold wurzel. I by no means presume to point to this omission as any disparagement of works of such research and reputation. The information seems not to have been required by those most interested, and consequently has not been thought worth making public. It cannot be doubted, now that agriculture invites the attention of so many eminent men, that all such deficiencies will soon be supplied. Dr. Daubeney's table of the 'Constituents of Crops,' compiled from the works of Boussingault and Sprengel, and published in the last volume of the Royal Agricultural Society's 'Journal,' conveys most useful information; but were the proportions of the proximate principles of vegetables appended, it would be rendered far more valuable.—W. H. H.

tables which afford to animals substantial nourishment. Now it happens that all these nutritive principles in roots are specifically heavier than water ; for with water at 1000 as the standard, sugar and starch vary in weight from 1500 to 1600. The specific gravity of gluten and albumen I have not been able to find in published works, but they sink in water, and are of course specifically heavier.*

It may perhaps be supposed that the soluble salts, and insoluble earths and oxides, are sufficient to disturb the accuracy of any inference from the relative specific weights of the water, and of the other constituents of the plant. Their amount, however, seems so trifling (the soluble salt in the potato giving only a little more than 8, and the insoluble earth, &c., less than 5 parts in the 1000) that the difference of their specific weights would do little more than turn the scale ; and it should be observed that, as, for the most part, the soluble salts, if not in excess, perform a part in animal nutrition, they may be considered as partially nutritive, while they are also specifically heavier than water ; and of the insoluble earths and oxides, which are not taken up in the process of digestion, some are lighter and others heavier than water. From the details of Eynhoff, given in Thomson's '*Vegetable Chemistry*,' their proportions seem to be such that the sum of their specific gravities (in the potato 1093) varies only a trifle, as compared with water—a difference which, as applied to only 5 parts in 1000, could but very slightly disturb the relative weights of the 700 of water, and of the 274 of the nutritive matter, which are to one another as 1000 to 1500 or 1600. It is true that, from Sprengel's tables, published by Dr. Daubeny in the '*Royal Agricultural Journal*,' the fixed ingredients in beet and swede turnip are considerably greater than in the potato or white turnip ; but it seems probable, as with the potato, that the several specific weights of these ingredients, in each root, either neutralise one another, or tell in positive aid of nourishment. Admitting this mode of estimating nourishment to be—as, in fact, it only can be—an approximation, it is certain at least that, in as much as so large a proportion of these roots consists of water, the absolute weight of a crop alone must be a still more deceptive estimate of its value. The weight of the nutritive ingredients, separate from the water, is what we want, and this the specific gravity of the root seems to give nearly enough ; for it is, in fact, a pretty close measure of their weight, minus the weight of water in the root, which is lost,

* The proportion of nourishment due exclusively to gluten, and the other azotized ingredients of food, is of course not to be detected by the mechanical process here proposed. The sum of the solid ingredients, as compared with the water of the plant, is all that can be learnt from it.—W. H. H.

or rather balanced, when the root is weighed in water.* Still, in practice, a more serious source of uncertainty remains. Roots by drying, without proportionate shrinking, may, indeed must, have some of their interstices filled with air; and thus, when weighed in water, appear lighter than they really are. Still, as this indicates the loss of water only, which is neutral as to specific weight, and negative as to nourishment, it does not perhaps entirely vitiate the criterion, particularly if it should be found that the specific gravities of the roots themselves correspond pretty uniformly with their nutritive powers, as inferred from chemical analysis or actual experience. None of the published tables which have fallen under my eye notice the specific weights of any agricultural productions; and suspecting them not to have been hitherto taken, I thought it worth while last year to take those of the turnip, the swede, the mangold wurzel, and the potato; but having reason to apprehend, from an inadvertence, a source of inaccuracy, these experiments have this year been repeated, roughly, it must be admitted, but still with as much accuracy as circumstances allowed. As the subject has not, I believe, been hitherto investigated, their publication may lead to further and useful inquiry. I beg, however, to premise that I only offer them with that view; and as for the speculations which accompany them, they are intended chiefly as illustrative of the advantages which may accrue from ascertaining and recording even such dry and abstract facts (if they are such) as specific gravities, but by no means as positively drawing any conclusions of my own.

1.	2. Number of Roots weighed.	3. Specific Gravity.	4. Amount of Nutritive Matter in 1000 parts. Analysis.	5. Equivalents of Nutritive Power. Experience.	6. Nitrogen in 100,000 lbs.
Turnips . . .	17	898.6	42	500	260
Swedes . . .	24	961.65	64		
Mangold wurzel .	36	1016.35	139		
Potatoes . . .	60	1095.	274 Eynhoff.		
				397 Beet.	370
				200	

Hence it will be seen that the order of the specific gravities coincides with that of the three following columns, as far as they

* The use of the saccharometer with liquids is exactly this:—It gives the weight of those very ingredients, minus that of the water in which they are held in solution; and, for all practical purposes, the saccharometer is considered as giving a true standard of nutritive contents, notwithstanding the similar objection, that the liquids to which it is applied (as in barley) contain precisely the same soluble ingredients as the vegetable.—W. H. H.

go. Column No. 5 is founded on Von Thaer's table, in which he takes 100 lbs. of ordinary hay as having given a certain amount of nourishment; and then finding, from similar experiments, 200 lbs. of potatoes, and 397 of beet, to give an equal amount, he calls them equivalents. The value of the turnip (*viz.* 500) is from an extended table of Professor Johnston's, based on exactly the same data. Swedes unluckily are not given.

Any immediate practical utility, from ascertaining the specific gravity to be a measure of nourishment, does not apply so directly to the above comparison between different roots as between varieties of the same root. The relative power of nourishment of different roots is pretty well ascertained; and if it is not, it is a matter of such obvious and general importance that more certain modes of learning it will of course be resorted to. Not so with the vast varieties of the same root, nor with the same sort in different soils, for which a quick and easy mode of taking their relative value would be desirable; for it will be rare that any one would be at the expense of having a number of chemical analyses merely to ascertain the different degrees of nourishment of the rohan, or Welsh kidney potato; nor certainly would any one be at the trouble of a series of experiments in feeding sheep on turnips, to put half-a-score on the Pomeranian globe, and another half-score on the border imperial; and yet these experiments offer some very curious details on these points, which scarcely seem to be the result of accident. Thus it becomes a matter of more importance to ascertain the general position than might have been at first sight imagined.

The following tables exhibit the different specific gravities in varieties of the same root:—

POTATOES.	Average Specific Gravity of 6 Tubers. 1841.	Average Specific Gravity of 12 Tubers. 1842.
Rohan	1081	1089·95
Purples	1091	1102
Welsh kidney . .	1107	1105

Now it is the received opinion among those who cultivate the potato in this district that the Welsh kidney requires a much richer soil than the purple, which is the common sort grown for consumption here—an opinion borne out by some experiments of mine, with which great pains were taken in the cultivation of

both. It is to be presumed that the plant requiring the richest soil is that which will yield the greatest nourishment; and, if so, the above figures indicate a specific weight corresponding with the higher nutritive powers of the Welsh kidney. The difference is certainly not great, the Welsh kidney giving only about 20 in 1000 more than the rohan; but the separate tubers from which the averages were taken, as well as the two years, gave remarkably uniform results.

Number of Roots weighed.		Specific Gravity.	Average Specific Gravity.	Nutritious Ingredients in 1000 lbs. Analysis. Herapath.
3	In Turnips, the			
3	Pomeranian globe averaged .	889	} 908.67	White turnip, 42
3	Green round ,, .	905		
3	Border imperial ,, .	932		
	In Swedes—			
6	Purple-topped } From Mr.	949	} 957.67	Swede, 64
6	Green } Pusey's farm.	952		
12	Skirving's }	972		
	In Mangold wurzel—			
6	Long red .	995.5	} 1015.97	Orange globe, 135 Sugar beet, 146
6	Red globe .	1005.9		
6	Yellow globe } From Mr.	1014.55		
6	Sugar beet } Pusey's farm.	1036.6		
12	Yellow globe. Stone brash .	1022.15		

These differences may appear small—that in the potato, between the heaviest and the lightest sorts, being only 26; in the turnip 43, in the swede only 23, and in the mangold wurzel 41—but it does not follow that the difference in nourishment is only in the same ratio; for the difference between the average specific gravity of the turnip and the swede was only 61, while their nutritive ingredients were 42 and 64. So the difference in the specific gravities of the mangold wurzel and the potato was only 79, but the nutritive ingredients were 136 and 274, the equivalents 397 and 200, and the nitrogen, as indicating nourishment, was 260 and 370. So that, though the actual difference in their specific gravities may be small, it seems probable they indicate greater differences in nourishment.

A comparison also was made of large and small roots, its object being to find out whether wide planting and large roots materially diminished density. The results were as follow:—

Number of Roots of each size weighed.		Specific Gravity. Large.	Specific Gravity. Small.	Difference.
4	<i>Turnips.</i> — Green round . . .	854	920	+ 66
3	<i>Swedes.</i> — Purple-topped . . .	944	955·6	+ 11·6
3	Green-topped . . .	970	934	— 36
6	Skirving's . . .	976	968	— 8
12	Average . . .	966·6	956·5	— 10·1
3	<i>Mangold-wurzel.</i> — Long red . . .	1006	984·3	— 21·7
3	Red globe . . .	998	1013·5	+ 15·5
3	Yellow globe . . .	1014·2	1014·9	+ ·7
3	Sugar beet . . .	1023	1049·8	+ 26·8
6	Yellow globe . . .	1015	1029·8	+ 14·8
18	Average . . .	1011·8	1020·3	+ 8·5

These results are irregular: whether this arises from accidental imperfections in the roots weighed, or from the peculiar habits of the plant, is impossible to say. The number of roots weighed are by no means such as to justify any sort of positive inference.

Another subject of comparison presented itself as to the probable effect of exposure on the upper as compared with the lower part of the same root, with reference to the question of earthing up for protection. The roots were cut in two at the line marked by the surface of the soil, and each part weighed—

Number of each part weighed.		Specific Gravity. Upper half.	Specific Gravity. Lower part.	Difference.
3	<i>Turnips.</i> — Green round . . .	881	921	40
3	<i>Mangold-wurzel.</i> — *Long red . . .	955	1014	59
3	*Red globe . . .	963	1001	38
3	*Yellow globe . . .	979	1017	38
6	Do. do. large . . .	1009·3	1022·9	13·6
6	Do. do. small . . .	1024	1038·7	14·7
6	<i>Swedes.</i> — Skirving's, large . . .	964	988·4	24·4
6	Do. small . . .	951	979	28

* All these were roots of 1841, and had been left in a dry room before

These results show pretty uniformly the diminished density which might have been expected from exposure, especially in the man-gold wurzel of 1841.

Whatever indication the above results may afford, nothing can be more certain than that little confidence can be reposed in them till they have been verified over and over again. The disturbances of soil, season, climate, and situation, will of course give great differences; and should others think it worth while to inquire farther into the subject, considerable discrepancies of general result must of course be expected; but it should be observed that the mode of comparison is offered chiefly as regards different varieties of the same root, treated under precisely similar circumstances, and where these causes of disturbance take no effect.

How far these crude experiments go towards substantiating the previous conjecture I must leave to others to judge. If it should appear that the specific gravity of roots is a test of their quality and nutritious contents, so simple a mode of ascertaining them would at once be applied in practice to an almost endless variety of useful purposes. The complicated results of different roots, and different varieties of the same root, as influenced by manure, soil, season, or climate—the times of planting, under all these circumstances—the mode of storing, and the best time of consuming them—are among the many points on which much light might be expected to be thrown.

It seems probable that the specific gravity of grain might in the same way be made available in ascertaining its nutritive properties. Indeed the *weight per bushel** is an approximation to the

they were weighed, besides being slightly touched by a frost before they were housed. For this reason they have not been admitted into other parts of the calculation, and are inserted here only as showing the effect of exposure.—W. H. H.

* An extensive and intelligent miller and baker observed to me that he always found the quality and his profits to be in proportion to the *weight per bushel* of the wheat bought. To a brewer it is in practice considered of even more importance, and must, in estimating quality, be regarded as a useful approximation to truth. But when we reflect on the extensive purchases made in these trades, and that very slight difference in the size or shape of the grains of corn makes a considerable difference in the bulk contained in the bushel, and interferes, in the same proportion, with the true estimate of quality, it is matter of surprise that some simple instrument, on the principle of the "thousand grain bottle," is not in general use. It is said that some millers and brewers occasionally buy by weight; but in that case allowance must be made for dampness of condition. This year wheat which, in consequence of the fine season and harvest, weighed, when cut, 65 lbs. a bushel, in about six weeks after was found to weigh only 62. Moist weather, situation of the rick not exposed to sun and air, or a damp granary, are well known to produce this effect, which therefore doubtless arises from absorbed moisture, and consequently increased bulk. Now in these cases the actual

specific gravity, but the size and shape of each grain materially influences the quantity contained in the bushel—a source of inaccuracy which would be avoided by weighing in water.

In touching on the relative degrees of nourishment of different vegetables, I may advert to another point which seldom receives the attention it ought—I mean the quantity of *nourishment per acre* afforded by different crops. When we speak of so many tons per acre of potatoes, mangold-wurzel, or swedes, or so many bushels of barley and oats, we rarely calculate the number of pounds of beef or mutton which they should respectively produce.

Von Thaer has given us the following table of equivalents which afforded equal nourishment to animals, taking 100 lbs. of ordinary hay as the standard :—

	Equivalents. lbs.
Wheat	27
Barley	54
Maize	59
Beans	83
Clover (red)	90
Hay (ordinary)	100
Potatoes	200
Beet	397
Wheat-straw	400

Professor Johnston, in his excellent little work on agricultural chemistry, has extended the above table considerably, as follows :—

	lbs.
Hay	10
Clover hay	8 to 10
Green clover	45 to 50
Wheat-straw	40 to 50
Barley-straw	20 to 40
Oat-straw	20 to 40
Pea-straw	10 to 15
Potatoes	20
Old potatoes	40
Carrots	25 to 30
Turnips	50
Cabbage	20 to 30
Peas and beans	3 to 5
Wheat	5 to 6
Barley	5 to 6
Oats	4 to 7
Indian corn	5
Oil-cake	2 to 4

weight or measure can never be as true a criterion as the specific gravity measured by an instrument.—W. H. H.

In this table Professor Johnston takes 10 as his standard for hay, and sometimes gives a varying equivalent. In using his figures in connexion with Von Thaer's, for the following calculation, I have adopted 100 as the standard in both cases, and have taken the mean of his varying equivalents. Thus, in the instance of wheat, which he gives as from 5 to 6, I have taken 55; but as this again differs from Von Thaer, who takes wheat at 27, I have again adopted the mean between the two, and call wheat 41. I have assumed the relative produce of the crops given in column 2 chiefly from those in Mr. John Morton's 'Report of Whitfield Farm,' and the weights in column 3 from the printed tables in his 'Farmer's Pocket-book.' It must be admitted that these assumptions are of an arbitrary character, and that calculations based upon them are proportionally doubtful; but it should be observed that the figures, both of Von Thaer and Professor Johnston, are given as the result of actual experiment in feeding animals by practical men. Professor Johnston himself has given a similar table to that which follows, but based on the constituents of different crops, chemically ascertained, as showing, by one set of figures, "the nutritive power of these crops" per acre, "in so far as they depend upon the starch and sugar they contain;" and by another as it depends on the gluten and albumen. The result are very interesting; but, as Lord Spencer observes, in his paper in the second volume of the Journal, 'On the Comparative Feeding Properties of Mangold-wurzel and Swedes,' the reasonable probability of the relative value of different foods, as deduced from chemical analysis, knowing so little as we do of the processes of nature in converting food into flesh, seems not quite satisfactory; and he prefers making his comparisons from the actual effect of food on animals. So also the equivalents of food, which in the two above tables are obtained from practical results in feeding, seem to me a preferable basis of calculation; but at all events the comparison of a table showing the nourishment per acre, as deduced from the quantities of the different nutritive ingredients, chemically ascertained, with one showing it obtained from actual experiment, would be interesting, and perhaps useful. In either case the presumed average crop per acre is an arbitrary amount, and must be assessed according to the different quality of the land to which the formula is to be applied; and however much any of us differ in these assumptions, the use of the calculation is still the same. Applying then the equivalent of nourishment in different crops to the average produce of these crops per acre, we get, from the following table, the relative nourishment per acre which those crops severally yield:—

1.	2. Assumed Average per Acre.	3. Taken at	4. Average per Acre, in lbs.	5. EQUIVA- lents of Nourish- ment.	6. Relative Nourishment, per Acre.	7.
Wheat . .	32 bush.	60 lbs. per bush. =	1,920	+ 41	46·9	} 34·2 Wheat.
.. Straw	30 cwt.	.. .. =	3,360	+ 450	7·46	
Peas . . .	20 bush.	.. .. =	1,200	+ 45	26·6	} Peas.
.. Straw . .	.. ..	.. .. =	.. ..	+ 123	.. ..
Barley . .	40 bush.	48 =	1,920	+ 54·5	35·2	} 42·6 Barley.
.. Straw . .	20 cwt.	.. .. =	2,240	+ 300	7·4	
Oats . . .	50 bush.	40 =	2,000	+ 55	36·3	} 51·2 Oats.
.. Straw . .	40 cwt.	.. .. =	4,480	+ 300	14·9	
Beans . . .	32 bush.	60 =	1,920	+ 61·5	31·2	} 41·17 Beans.*
.. Straw . .	40 cwt.	.. .. =	4,480	+ 450	9·97	
Clover hay .	30 cwt.	.. .. =	3,360	+ 90	37·3	} Clover hay.
Ordinary hay	20 cwt.	.. .. =	2,240	+ 100	22·4	
Potatoes . .	100 bags	280 lbs. per bag =	28,000	+ 200	140	Potatoes.
Cabbage . .	20 tons	.. .. =	44,800	+ 350	179·2	Cabbage.
Carrots . .	25 tons	.. .. =	55,000	+ 275	200	Carrots.
Beet . . .	25 tons	.. .. =	55,000	+ 397	138·5	Beet.
Green clover	6 tons	.. .. =	13,440	+ 475	28·29	Green clover.
Turnips . .	25 tons	.. .. =	55,000	+ 500	110	Turnips.

Now, without pretending that any very nice conclusions are to be drawn as to the relative advantages of one grain crop over another, which would seem, according to the average crops assumed in this case, to be nearly equal, or perhaps even of one root crop over another, unless when the difference is very remarkable, there is one very striking result in the vast excess of nourishment of the root over the seed crop. Thus the white turnip, which is the lowest in the scale of roots, gives twice as much nourishment per acre as the highest in the scale of grains; and the carrot, which is the highest of the root crops, gives nearly five times as much as barley and beans, which are the lowest of grain

* There is no equivalent given for bean-straw; nor can I find, in any of the tables, its probable value from the azote contained. The value of all straw for fodder must depend on the mode in which it is harvested. In Scotland, the order in which the farmer places his straw for fodder is—1st, pea; 2nd, bean; 3rd, oat; 4th, wheat; 5th, barley: while in England, where the bean is quite withered before it is cut, it stands last in the scale. Not to place it too low, I have adopted the same equivalent as that of wheat (viz. 450), which represents the least valuable of any straw, while that of barley is 300. This value, as between wheat and barley, neither accords with that indicated by the azote which they respectively contain, nor, I think, with that usually attached to them in practice; but it should be observed that, in comparing the general value of these crops, the difference can never be great which results from equivalents varying only from 300 to 500, as (with the exception of that of peas) is the case with all these straws where the average quantity per acre is never much below 1 ton, nor above 2. In calculating accurately the relative values of different straw as fodder, of course this difference becomes of more importance. It is remarkable in the seed-crops, that the greater or less quantities per acre, or equivalents of value either in seed or straw, seem so nicely to balance one another, that, on the total produce per acre, the quantity of nourishment only varies from about 42· in beans and barley, to 54·6 in wheat.—W. H. H.

crops ; or, according to the figures, the same quantity of ground which in carrots would feed 200 head of cattle or sheep, in cabbages would feed 179, in beet or potatoes 140, in turnips 110, but in wheat and oats would only feed from 50 to 55, and in beans or barley only 42.

When it is farther considered how much the rotation of our crops generally has been improved by the introduction of root culture, and how greatly also the soil suffers in the constant repetition of grain crops, from so much of its fertility finding its way to market in the shape of corn (the straw only being returned as manure), while, on the other hand, in root crops, little, though at last doubtless some of the staple of the soil, unless replaced by an equal amount from a distance, vanishes in the shape of beef and mutton—and when it is considered also, in root crops, that the manure is in proportion to the increased quantity of food produced, and numbers of animals fed, and has circulated so much oftener through the soil—we cease to be surprised at the vast increase in the value of light land ; and those who cultivate heavy soils, hitherto unacquainted with any better rotation than wheat, beans, and a fallow, should be on the alert, now that thorough draining and subsoiling are seen to introduce root culture on land heretofore unacquainted with swedes or sheep.

There are many other details which such a calculation as the above will naturally suggest to those who apply it. For instance, the carrot, and perhaps the cabbage, if taken at a higher quantity per acre, are nearly as 2 : 1, while the potato and the beet are nearly as 3 : 2, richer than the turnip. An acre of green clover, which, according to Sinclair's experiments, recorded by Sir H. Davy, is taken as four times heavier than it is when made into hay, gives only 28·29 of nourishment, while as hay it gives 37·3—the laxative effect of such an excess of water in the food possibly counteracting the effect which should otherwise be drawn from its nutritive contents.

But the object of the present paper, as was observed before, is not to draw conclusions, the data of which partake more or less of an arbitrary character ; yet thus far we may safely conclude. If these data are correct, they lead to the most important results. Let us then apply a similar calculation to a case where our data are most unexceptionable.

In Lord Spencer's valuable experiment on the relative nutritious property of swedes and mangold-wurzel, given at p. 296 of vol. ii. of the Society's Journal, it appears that, in feeding two oxen on swedes and mangold-wurzel, 2 tons of swedes gave at the rate of 64 lbs. of beef, while 2 tons of mangold-wurzel gave 102½ lbs. The average of the two crops on one of the farms in this neighbourhood, where the most accurate accounts of produce

are kept, was this year 19 tons of swedes per acre, while that of the mangold-wurzel was 26; and my own farm gave at the rate of 20 tons of swedes, and 32 of mangold-wurzel, but the season was peculiarly favourable to the latter crop. Assuming, then, on precisely similar land, 20 tons of swedes, and only 25 of mangold-wurzel, to be a fair average, it seems that, while one acre of swedes would only have given 640 lbs. of beef, an acre of mangold-wurzel would have given 1275, so that a crop of the latter is worth nearly double one of the former. I am quite aware that there are many circumstances under which the cultivation of swedes is preferable to mangold-wurzel. I would only apply the particular instance where such circumstances do not exist.

In this case the facts are certain, and have long been made public, and yet how few of us are aware of the important consequences to which they lead, that, as in the last instance, by preferring one crop to another, double the stock may be maintained by the land. It will doubtless require more manure, but it gets it just in proportion to the number of cattle that it feeds. What is lost to it in the flesh of the animal sent off must certainly be restored from extraneous sources; but it will be rare indeed where the necessary quantity of one sort or another cannot be obtained by the expenditure of a very small proportion of the increased returns from the doubled produce of the land.*

* Of course this presumes all the manure from the cattle to be carefully made the most of. If it is, and the land kept in fine tilth, so as to derive the full benefit of those elements which for the most part, if not entirely, may be derived from air and rain, and which form the chief part of vegetable structure, as well as animal nutrition, the manure to be bought will be much less than is generally imagined, and in a great measure limited alone to the fixed ingredients of the soil, which, after all, form a small part of the grain, or the animal, which finds its way to market. Taking Liebig's supposition that a $\frac{1}{2}$ of a grain of ammonia may be contained in 1 lb. Hessian of rain-water, and allowing the rain in England to contain the same quantity, the average rain of a year should contain, upon an English acre, 161·88 lbs., or nearly 162 lbs. of ammonia. According to Payen, 1000 lbs. of farm-yard manure contain 4 lbs. of nitrogen: thus a ton will contain 8·96 lbs. This nitrogen is in the shape of ammonia, which, according to Thomson's estimate, is composed, by weight, of hydrogen 0·375 lbs., and of nitrogen 1·75.

There is therefore to be added to the . . . 8·96 lbs. of nitrogen,
1·92 „ hydrogen,

Giving, as the total of ammonia contained in a } 10·88 lbs.
ton of farm-yard manure, . . . }

The annual quantity of ammonia poured with the rain on an English acre was 161·88 lbs., or a quantity equal to that which would have been given by 14·87 tons of farm-yard dung (about two-thirds of a good dressing), the whole of which, if the surface of the soil is kept loose and light, is brought in contact with and appropriated either by the humic acid with which it combines, forming a soluble humate of ammonia; or, according to the dis-

We see then the vast use of such tables as those of Von Thaer and Professor Johnston. If their data are not thought to be sufficiently ascertained, should time be lost in verifying them? It is in the power of any of us who will take the trouble of making the very simple experiment which Lord Spencer made, to learn, with something like certainty, the nutritive value of one or two of the crops proper to our own soil; and this has been the chief object of the present paper. It was not intended to prove this or that probable or conjectural position; but, by drawing legitimate and important conclusions from such premises as we have, to illustrate, in as strong a point of view as possible, to practical men, who are sometimes too apt to undervalue an experiment, how simple the process, and yet how incalculably extensive the benefits, if each of us will but ascertain and record a fact.

Painswick, March 8, 1843.

XI.—Sanitary Effects of Land Draining.

[From Mr. Chadwick's Report to the Poor Law Commissioners.]

IN considering the circumstances external to the residence which affect the sanitary condition of the population, the importance of a general land drainage is developed by the inquiries as to the causes of the prevalent diseases, to be of a magnitude of which no conception had been formed at the commencement of the investigation: its importance is manifested by the severe con-

ciples of Liebig, who repudiate humic acid, by the alumina and other ingredients of the soil which are known to have the power of absorbing and retaining it in large quantities, till required and taken up by the rootlets of the plants—a circumstance which may explain Tull's idea that tilth supplied the place of manure. If, on the other hand, the surface of the soil is left baked and hard, most of this ammonia (which, be it remembered, is equal in quantity per acre to that contained in 14 tons of farm-yard dung) is evaporated, and carried off to the better tilled field of our neighbour.

This natural supply of ammonia may not, however, be enough to restore the nitrogen abstracted from the land in vegetable and animal produce. Whatever that difference (and it would not be very difficult to get a good general estimate of its amount), it must of course be supplied by art.

Whether the rain and carbonic acid of the atmosphere will supply all the rest of the elements required by the vegetable principles is at present matter of dispute, but it is agreed on all hands that they supply a very large portion of them. What they do not, must also be obtained by artificial means. With these exceptions, there is nothing else to be restored to the soil but its fixed ingredients. That they are comparatively small in quantity is perfectly ascertained. To estimate what that quantity is, even as regards all these ingredients severally, now that the analytical and arithmetical part of agricultural chemistry has made such rapid strides, is by no means beyond the reach of calculation.—W. H. H.

sequences of its neglect in every part of the country, as well as by its advantages in the increasing salubrity and productiveness wherever the drainage has been skilful and effectual. The following instance is presented in a report from Mr. John Marshall, jun., the clerk to the union in the Isle of Ely:—

“ It has been shown that the Isle of Ely was at one period in a desolate state, being frequently inundated by the upland waters, and destitute of adequate means of drainage; the lower parts became a wilderness of stagnant pools, the exhalations from which loaded the air with pestiferous vapours and fogs; now, by the improvements which have from time to time been made, and particularly within the last fifty years, an alteration has taken place which may appear to be the effect of magic. By the labour, industry, and spirit of the inhabitants, a forlorn waste has been converted into pleasant and fertile pastures, and they themselves have been rewarded by bounteous harvests. Drainage, embankments, engines, and enclosures have given stability to the soil (which in its nature is as rich as the Delta of Egypt) as well as salubrity to the air. These very considerable improvements, though carried on at a great expense, have at last turned to a double account, both in reclaiming much ground and improving the rest, and in contributing to the healthiness of the inhabitants. Works of modern refinement have given a totally different face and character to this once neglected spot; much has been performed, much yet remains to be accomplished by the rising generation. The demand for labour produced by drainage is incalculable; but when it is stated that where sedge and rushes but a few years since grew we now have fields of waving oats and even wheat, it must be evident that it is very great.

“ On reference to a very perfect account of the baptisms, marriages, and burials, in Wisbeck, from 1558 to 1826, I find that in the decennial periods, of which 1801, 1811, and 1821, were the middle years, the baptisms and burials were as under:—

	Baptisms.	Burials.	Population in 1801.
1796 to 1805	1,627	1,535	4,710
1806 to 1815	1,654	1,313	5,209
1816 to 1825	2,165	1,390	6,515

“ In the first of the three periods the mortality was 1 in 31; in the second, 1 in 40; in the third, 1 in 47; the latter being less than the exact mean mortality of the kingdom for the last two years. (See ‘Registrar-General’s Second Report,’ p. 4, folio edition.) These figures clearly show that the mortality has wonderfully diminished in the last half century, and who can doubt but that the increased salubrity of the fens produced by drainage is a chief cause of the improvement.”

Mr. R. Turner, medical officer of the Newhaven union, states,—

“ The district which has been under my care comprises five parishes, three of which, viz., Kingstou, Iford, and Rodmell, are (more especially the two latter) situated in close proximity to marshes, which were formerly for a considerable portion of the year inundated; of late very ex-

tensive improvements have taken place in the drainage of these levels, and in consequence of that change, the diseases constantly engendered by marsh miasmata, viz., typhus and intermittent fevers, are not more common than in other districts which present to the eye a fairer prospect of health."

Mr. G. R. Rowe, medical officer of the Ongar union, observes,—

"It is worthy of remark, that in the districts surrounding Chigwell no malignant, infectious, or contagious disease has appeared during my experience of thirty years' occasional residence, and even during the prevalence of cholera not one case occurred. The land is well drained, the situation elevated, and the cleanly habits of the poor, with the benevolence of its residents, have tended much to the prevention of disease, and its amelioration when occurring."

Mr. W. Sanders, medical officer of the Gravesend and Milton union, states,—

"I beg leave to suggest how extreme are the beneficial effects of a proper drainage, which shall prevent stagnant water, and its deleterious consequences, accumulating in crowded neighbourhoods. This is exemplified in this town, and also in Tilbury Fort opposite, which is built on a marsh, and where, during the cholera period, then under my care, not a single case occurred."

Mr. Emerson, one of the medical officers of the Eastry union, states,—

"There is, I believe, no locality which has been for some years so exempt from fevers of a malignant and contagious character as the eastern coast of Kent. Accordingly, idiopathic fever, under the form of synchus and typhus, very rarely occurs, and when it does appear, is generally of an isolated kind. Intermittents, also, which fifteen or twenty years since were so generally prevalent in this district, have become comparatively of rare occurrence, and indeed have almost disappeared from the catalogue of our local endemics. This exemption from ague and other febrile epidemics of an infectious nature may be justly imputed to the total absence of malaria, and of all those causes which usually generate an unwholesome and contaminating atmosphere, viz., from the whole district being secured from inundations by the most complete and effectual system of drainage and sewerage. Also, from the exposed state of the country favouring a free and rapid evaporation from the surface of the soil."

Mr. George Elgar, another of the medical officers of the Eastry union, observes that,—

"The parishes forming the fifth district of the Eastry union are, with one or two exceptions, close to marshes separating the Isle of Thanet from this portion of East Kent, and consequently, during the spring and autumn, the inhabitants are exposed to the malaria therefrom; but for these last few years, owing to the excellent plan of draining, very few diseases have occurred (in my opinion) that can be said to be produced by malaria. There is very little ague, scarcely any continued fevers;

the borders

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In the reports given from the parish ministers in the statistical accounts of Scotland, the effects of drainage upon the general health of the population are strongly marked in almost every county, expressed in notes made from an examination of the returns. Sutherland—parish of Rogart, "healthy, and a good deal of draining." Farr, "subject to no particular disease; a deal of draining." Ross and Cromarty—Allness, dry and healthy, "climate improved by drainage." It is to be understood that drainage appears to form the essential part of agricultural improvement, which is connected with the improvement of health. Thus the notes from another parish in the same county, Kilmuir Wester and Suddy, states it as "healthy; great improvement; scarcely an acre in its original state." Rosemarkie, "healthy; agriculture much improved." Elgin—New Spynie, "healthy, much waste reclaimed, much draining." Alves, "dry and healthy, well cultivated, wood sometimes used for drains." Banff—Deckford, "healthy, and people long lived, much draining." Kincardine—Fordoun, "so much draining that now no swamps, formerly agues common, now quite unknown." Angus—Carmylie, "health improved from draining." Kinross—Kinross, "agues prevalent sixty years ago in consequence of marshes, now never met with." Oswell, "ague prevailed formerly, but not since the land was drained." Perth—Methven, "the north much improved by draining." Redgorton, "healthy; no prevailing disease; ague was frequent formerly, but not since the land has been drained and planted." Moneydie, "healthy; an immense improvement by draining." Abernethy, "since the land was drained, scrofula rare and ague unknown." Monzie, "healthy; a good deal of land reclaimed." Auchterarder, "much draining, and waste land reclaimed—climate good." Muckhart, "great improvement in agriculture; ague formerly prevalent—not so now." Muthill, "healthy, much draining and cultivation extended." And similar statements are made from the rural districts in all parts of the country.

In the course of inquiries as to what have been the effects of land drainage upon health, one frequent piece of information received has been, that the rural population had not observed the effects on their own health, but they had marked the effects of drainage on the health and improvement of the stock. Thus the less frequent losses of stock from epidemics are beginning to be perceived as accompanying the benefits of drainage in addition to those of increased vegetable production.

Dr. Edward Harrison, in a paper in which he points out the connexion between the rot in sheep and other animals, and some important disorders in the human constitution, observes,—

"The connexion between humidity and the rot is universally admitted

by experienced graziers ; and it is a matter of observation, that since the brooks and rivulets in the county of Lincoln have been better managed, and the system of laying ground dry, by open ditches and under-draining, has been more judiciously practised, the rot is become far less prevalent. Sir John Pringle informs us, that persons have maintained themselves in good health, during sickly seasons, by inhabiting the upper stories of their houses ; and I have reason to believe that, merely by confining sheep on high grounds through the night, they have escaped the rot."

Dr. Harrison makes some observations on the effects of imperfect drainage in aggravating the evils intended to be remedied, of which frequent instances are presented in the course of this inquiry,—

"A grazier of my acquaintance has, for many years, occupied a large portion of an unenclosed fen, in which was a shallow piece of water that covered about an acre and a half of land. To recover it for pasturage, he cut in it several open ditches to let off the water, and obtained an imperfect drainage. His sheep immediately afterwards became liable to the rot, and in most years he lost some of them. In 1792 the drains failed so entirely, from the wetness of the season, that he got another pond of living water, and sustained, in that season, no loss of his flock. For a few succeeding years, he was generally visited with the rot ; but having satisfied himself by experience, that whenever the pit was, from the weather, either completely dry or completely under water, his flock was free from the disorder, he attempted a more perfect drainage, and succeeded in making the land dry at all times. Since that period he has lost no sheep from the rot, though, till within the last two years, he continued to occupy the fen. . . .

"Mr. Harrison, of Fisherton, near Lincoln, has by judicious management laid the greatest part of his farm completely dry, and is now little troubled with the rot, unless when he wishes to give it to some particular animals. His neighbours, who have been less provident, are still severe sufferers by it, nor are their misfortunes confined to sheep alone. Pigs, cows, asses, horses, poultry, hares, and rabbits, become rotten in this lordship, and have flukes in their livers. . . .

"The late Mr. Bakewell was of opinion, that after May-day, he could communicate the rot at pleasure, by flooding, and afterwards stocking his closes, while they were drenched and saturated with moisture. In summer, rivers and brooks are often suddenly swollen by thunder-storms, so as to pass over their banks, and cover the adjacent lowlands. In this state, no injury is sustained during the inundation ; but when the water returns to its former channel, copious exhalations are produced from the swamps and low lands, which are exceedingly dangerous to the human constitution, and to several other animals, as well as sheep. . . .

"A medical gentleman of great experience at Boston, in Lincolnshire, and who is considerably advanced in life, has frequently observed to me, that intermittents are so much diminished in his circuit, that an ounce of the cinchona goes further at this time in the treatment of agues than a pound of it did within his own recollection. During his father's practice at Boston, they were still more obstinate and severe. For my own

part, I have declared, for several years, in various companies, that marsh miasmata are the cause of both agues and the rot. And as miasmata are admitted, by the concurring testimonies of medical practitioners in every part of the globe, to be produced by the action of the sun upon low, swampy grounds, I hope this interesting subject will be fully investigated, and effectual plans carried into execution, for the preservation of man, and of the animals which are so useful to him."

I may here mention a circumstance which occurred at the Poor Law Commission Office, and which with succeeding information tended to direct our attention to the subject of sanitary measures of prevention for the protection of the rates. A medical officer of one of the Unions, who came to town for the transaction of some business before the Board, begged to be favoured by the immediate despatch of his business, inasmuch as, from a change of weather which had taken place since his departure, he was certain that he should have a number of cases waiting for him. On being asked to explain the circumstances from which he inferred the occurrence of disease with so much certainty, he stated that within his district there was a reservoir to feed a canal: that they had let out the water as they were accustomed to do in spring time for the purpose of cleansing it; and that whenever such weather occurred as then prevailed during the process, he was sure to have a great number of fever cases amongst the labourers in the village which immediately adjoined the reservoir. It appeared to be, in fact, a case in which the rot was propagated amongst the labourers in the village under circumstances similar to those before cited in which it was propagated amongst the sheep.

The following portions of evidence afford instances of the condition in which a larger proportion of the country remains, from the neglect of general land drainage, than would be conceived from any *à priori* estimate of the amount of prevalent intelligence and enterprise.

Mr. R. W. Martyr, one of the medical officers of the Langport union, thus describes the condition of a large proportion of his district:—

"The parishes of Kingsbury and Long Sutton being the district No. 1 B of the Langford union, the population of which amounts to above 3000; Kingsbury, containing 2000; and Long Sutton 1000, or thereabouts. Both these parishes are partly surrounded by low meadow land, and are liable to frequent inundations, often covering many thousand acres, and sometimes to a great depth; the level of much of this land, being below the bed of the main river or drains, makes it very difficult (when once inundated) in very wet seasons to drain or carry off the immense body of water they often contain.

"These inundations are caused by the banks of the main rivers not being sufficiently strong or elevated, and from the bridges not being

capacious enough to carry the immense body of water brought down from the neighbouring hills and country higher up, which, in heavy rains, sometimes takes place so rapidly as to completely overflow the banks in twenty-four hours; but besides the casual or accidental giving way of the banks of the rivers, it is sometimes done by interested persons for the purpose of warding off the mischief from themselves by throwing it on their neighbours.

"When these floods occur in the winter season, and there is but little herbage, or early in the spring, and are followed by dry weather, the surface of the ground becomes dry and healthy, and they are then highly beneficial to the land, and but little prejudicial to the health of the surrounding inhabitants; but when, as is sometimes the case, these floods take place late in April, May, and June, and cover hundreds of acres of hay, some cut and some uncut, and which must of course rot on the ground, the effluvia and stench are then often unbearable, and highly prejudicial to the health of the neighbouring villages, and it is sometimes years before the land recovers its healthy state, producing nothing but rank herbage, and causing agues, fevers, dysentery, and numerous other diseases. Many of these evils may, I think, be remedied if the owners of large estates in this neighbourhood would interest themselves in the matter: I am persuaded the increased value of their property would amply repay the outlay necessary for the purpose. When the land is in this unhealthy state, it appears to be equally prejudicial to the animal as the human subject, producing numerous diseases among cattle, particularly among sheep, many farmers losing the whole of their flocks.

"Although much remains to be done to remedy the mischief complained of, yet a considerable improvement has taken place within the last twenty years by enclosing many of the large commons, and by that means partially draining them; and also by enlarging the back drains which carry the water to a lower level into the main river, by which means it is carried off much sooner, and less mischief is done, than if it remained longer on the surface of the land.

"It is stated in a very old history of Somerset, that about 300 years ago, nearly the whole of the inhabitants of Kingsbury, Muchelney, and Long Load, were carried off by a pestilence (without doubt meaning a malignant fever); and that for many years afterwards it was considered so unhealthy that it was inhabited solely by outlaws, and persons of the worst character, a clear proof the country is in a much healthier state now than it was in former times.

"In addition to the more general causes of disease arising from the flat state of the country, and its liability to inundations, are many others of a more local character, and much easier of removal, in the village of Kingsbury; and in many others there are numerous pits or ponds in the winter season filled with muddy water, and, in summer, mud alone: these are often situated in the front or at the back of the cottages, and are receptacles for all manner of filth, and in certain seasons are productive of very serious diseases, and at all times highly injurious to health. Besides the mud pits above mentioned, there is scarcely a cottage that is not surrounded with all manner of filth, oftentimes close to

the doors of the inhabitants, very few of the cottages being provided with privies, or, if there be any, they only add to the general nuisance from being open and without drains."

Mr. Oldham, the medical officer of the Chesterfield union, gives the following account of his district:—

"Wessington is situated upon an elevation, but the houses are arranged around a green or unenclosed common, upon the surface of which are a great number of small pools, which, for the most part, are stagnant. In the winter season they overflow, and at this season the neighbourhood appears less infected with fever. In the summer months, and greater part of the spring and autumn, they are stagnant, and undoubtedly a fruitful source of malaria; indeed the neighbourhood of Wessington is scarcely ever free from fever at these seasons of the year.

"It perhaps may not be amiss to mention, I have attended a number of persons in the neighbourhood of this common who have been attacked with fever, who were at the same time well fed, and lived in comfortable and tolerably well-ventilated houses."

He then adduces instances, and proceeds—

"From the facts before mentioned, I am led to conclude that the decomposition constantly going on in these small pools is the source of the malaria, and that the malaria so engendered propagates fever. 1st. Because there are cases of fever in this locality nearly all the year. 2nd. Because paupers, and persons who are better fed, and live in more comfortable and better ventilated houses in the neighbourhood of this green or common, are attacked with the disease, and, I may say, almost indiscriminately. 3rd. Because during the years I have attended the paupers of the district, there has scarcely been a case of fever in the winter season when the pools are overflowed, and the atmosphere is colder, and consequently unfavourable to fermentation and decomposition. In my opinion the only method to remedy this evil would be to drain the common, which is small, and its situation being elevated, would greatly facilitate its drainage. The condition of a few of the smaller and more confined of the tenements might be greatly improved."

Mr. R. Reynolds, one of the medical officers of the Dore union, thus describes in his report the district where some fever cases occurred:—

"Of those cases the six first have occurred on Colston Common, a small marshy spot, never drained, and containing several pools extremely unhealthy, from decaying vegetables that never are removed. This year the same families have been again attacked, and shall be so every year till that nuisance be removed. In a medical point of view, such commons are injurious, and they are extremely expensive to the unions, for they cause fever, asthma, and rheumatism, from their incipient moisture, thus injuring the labouring classes, and heavily taxing the parish.

"The four next have occurred at a place called Toad Ditch: it well

deserves the name; it is a collection of badly-built houses, rendered unhealthy from the large ditch, into which every kind of refuse is poured; the removal of that nuisance is imperatively called for. All these houses have one privy in common, but the ditch is the place generally used.

"This district would be much served by enclosing and draining Colston Common, by keeping the sewers at Kingston clean, and by draining the ditch at Toad Ditch. These are the only removable nuisances of which I have any knowledge."

Mr. Blick, medical officer of the Bicester union, describes the prevalence of typhus:—

"This disease has been very prevalent in this district during the past year, indeed we are never free from it. I think its origin may be traced, in most instances, to a constant exposure to an atmosphere loaded with malaria, and propagated, in the second place, by contagion, so little attention being paid to prevent its diffusion.

"The malaria alluded to arises from the decomposition of vegetable matter left upon Otmoor (a marsh of about 4000 acres), by the previous winter's flood, and acted upon by the sun, &c., during the summer."

Mr. J. Holt, the medical officer of the Leighton Buzzard union, reports:—

"I have had only 34 cases of remittent and intermittent fevers during the last year, which is a small number in comparison to the amount usually occurring in hot summers. The great prevalence of these fevers at such times is attributable principally to the number of stagnant ponds and ditches which are situated in the very midst of many of the towns and villages of this union, and which, in hot weather, become quite putrid and offensive from the quantity of decaying animal and vegetable matter. I have generally observed that the greater number of these fevers occur in houses situated in the immediate vicinity of these ponds, and have no doubt is the chief cause of nearly all the fevers of this description. The villages to which I more particularly refer are Egginton, Eddlesbon, Cheddington, &c."

The sanitary effects of road cleansing, to which house drainage and road drainage is auxiliary, it appears are not confined to the streets in towns and the roads in villages, but extends over the roads at a distance from habitations on which there is traffic. Dr. Harrison, whose testimony has been cited on the subject of the analogy of the diseases of animals to those which affect the human constitution, in treating of the prevention of fever or the rot amongst sheep, warns the shepherd that, if after providing drained pasture and avoiding "rotting-places" in the fields, all his care may be frustrated if he do not avoid, with equal care, leading the sheep over wet and miry roads with stagnant ditches, which are as pernicious as the places in the fields designated as "rotting-places." He is solicitous to impress the fact that the rot, *i. e.* the

typhus fever, has been contracted in ten minutes, that sheep can at "any time be tainted in a quarter of an hour, while the land retains its moisture and the weather is hot and sultry." He gives the following instance, amongst others, of the danger of traversing badly drained roads. "A gentleman removed 90 sheep from a considerable distance to his own residence. On coming near to a bridge, which is thrown over the Barling's river, one of the drove fell into a ditch and fractured its leg. The shepherd immediately took it in his arms to a neighbouring house, and set the limb. During this time, which did not occupy more than one hour, the remainder were left to graze in the ditches and lane. The flock were then driven home, and a month afterwards the other sheep joined its companions. The shepherd soon discovered that all had contracted the rot, except the lame sheep; and as they were never separated on any other occasion, it is reasonable to conclude that the disorder was acquired by feeding in the road and ditch bottoms." The precautions applicable to the sheep and cattle will be deemed equally applicable to the labouring population who traverse such roads.

Such instances as the following, on the prejudicial effects of undrained and neglected roads, might be multiplied. Mr. E. P. Turner, the medical officer of Foleshill union, in accounting for some cases of fever, states,—

"These cases of typhus all occurred in the same neighbourhood, where the road is bad and a dirty ditch of stagnant water on each side of it; the road is generally overflowed in the winter. The disease broke out in the month of October; other cases occurred in the same neighbourhood at the time."

The nature of the more common impediments which stand in the way of the removal of the causes of disease and obstacles to production described in the preceding, are noticed in the instances following. Others will be adduced when the subject of the legislative means of prevention is stated.

Dr. Traves, on the sanitary condition of the poor in the Malton union, states,—

"The whole of the low district above alluded to, and extending into the Pickering union (known by the name of the Marishes, or Marshes), has at different times within the last few years been the seat of typhus and other fevers.

"Attempts were made by some of the landed proprietors a few years ago to effect a system of drainage and embankments likely to prevent the inundations of these rivers in wet seasons, but the attempt was abandoned in consequence of the reluctance of certain townships to bear their portion of the necessary outlay, and any partial system of embankment is positively injurious, inasmuch as the water that is let in upon the land at a higher point of the river is prevented returning into the

stream again by an embankment at a lower point, so that this water, containing vegetable matters in a state of decomposition, must remain stagnant until evaporated by the sun's rays, or dissipated by the wind ; cases of fever occurring under these circumstances have repeatedly come under my observation, as well as that of other medical men familiar with the district, and this fruitful source of disease (in seasons like 1839 more especially) will probably now remain in full force until an Act of the legislature shall effect a change."

Mr. Thomas Marjoribanks, the minister of Lochmaben,—

"No means of any consequence, so far as I am aware, have yet been tried to remedy the evil, the removal of such substances as generate malaria. There are no scavengers appointed for the removal of nuisances. One great means of preventing the generation of malaria (in my opinion) would be the lowering of the bed of the river Annan, which would to a great extent free the surrounding lands of stagnant water, give greater facilities for draining, improve the system of farming, lessen the risk of damage, and increase the quantity as well as improve the quality of the food which the low lands produce, and in every way conduce to the comfort and cleanliness of the inhabitants. It is computed that in consequence of the flooding of the Annan, damage during the last four years has been done to the amount of 6000*l.*, and this along only about three miles of its course. The property is very much subdivided, and, in consequence, poverty and want have increased to a great extent among the small proprietors."

In closing this exposition of the state of the chief external evils that affect the sanitary condition of the labouring population, it may be observed that the experience, on which the conclusions rest as to the principles of prevention, is neither recent nor confined to this country. That which is new, is the advantages we possess beyond other times, and perhaps beyond all other countries, in capital and practical science for its application. The experience of the advantage of public sewers to the health of a town population is nearly as old as Rome itself. I may refer with M. Du Châtelet to the experience of that city, to illustrate the consequences of neglect, such as are manifest amidst large masses of the community throughout the country, and are partially displayed in the mortuary registers first cited. He gives the details from the treatise '*De Adventitiis Romani Cœli Qualitatibus*,' by the celebrated Italian physician Lancisi, who deeply studied the sanitary condition of Rome, and wrote several admirable works on the subject, which had the happy effect of inducing the pope to cleanse and drain the city:—

"The barbarians of every tribe having several times pillaged and sacked the city of Rome, the aqueducts were destroyed, and the water, spreading into the surrounding plains, formed marshes, which contributed greatly to render uninhabitable the surrounding country.

"The aqueducts existing no longer, the sewers and privies were alike

neglected, and produced serious and frequent sicknesses, which were more effectual in destroying the population than the arms of the barbarians. All the historians of these remote times, and particularly St. Gregory, in his Homilies, and the deacon John, in the Life of that saint, give a frightful picture of the city of Rome. The air became so vitiated that plagues and fevers of a malignant character continually carried on their ravages to such a point that Peter Damien, writing in the eleventh century to Pope Nicholas II., to entreat him to accept his resignation, alleged as the pretext the danger he ran every instant of losing his life by remaining in the town.

"It was principally during the abode of the popes at Avignon that all which regards health was neglected at Rome, and some historians have not hesitated to attribute to this negligence the depopulation of the town, which was reduced in a little time to 30,000 inhabitants.

"Things remained in this state to the end of the fourteenth century, an epoch at which the popes, resuming the ancient labours, restored things to their proper condition; a new title to glory of Leo X., who of all the popes was the one who occupied himself with this important object in the most especial manner.

"It is, in part, to these precautions that we are to attribute the rapid increase of the population of Rome, which, from 30,000 souls, reached in a short time to 80,000; and it is a thing worthy of our attention that after the death of this pontiff the population quickly fell to the number of 32,000, because, according to the contemporary authors, everything having been neglected, the first calamities were renewed.

"Happily for Rome this state of things did not continue long, because all successive popes, instructed, it appears, by the experience of ancient times, having carried on immense labours, and constructed fresh sewers, have given to the air of this city the necessary purity."

Italy presents instances, though comparatively modern, of the removal of disease by land drainage:—

"At Varreggio," observes M. Villermé, "in the principality of Lucca, the inhabitants, few in number, barbarous, and miserable, were annually, from time immemorial, attacked about the same period with agues; but in 1741 floodgates were constructed, which permitted the escape into the sea of the waters from the marshes, preventing at the same time the ingress of the ocean to these marshes both from tides and storms. This contrivance, which permanently suppressed the marsh, also expelled the fevers. In short, the canton of Varreggio is at the present day one of the healthiest, most industrious, and richest on the coast of Tuscany; and a part of those families whose boorish ancestors sunk under the epidemics of the *aria cattiva*, without knowledge to protect themselves, enjoy a health, a vigour, a longevity, and a moral character unknown to their ancestors."

XII.—*Report by the Committee of the Morayshire Farmer Club, appointed to inspect and to report on the Experiments made in raising Turnips by means of Sulphuric Acid and Bone-Dust.* Communicated by the Duke of RICHMOND.

THE Committee found that the only members of the Club who had tried the experiment were Mr. M'William, Sheriffston, and Mr. Geddes, Orbliston, the former of these gentlemen having also used guano.

The Committee have much pleasure in reporting the success of the experiments, whereby a great discovery has certainly been made, which, if judiciously followed up, must tend to diminish very materially the heavy expense the farmer is now put to in raising a crop of turnips, from the very high price of bone-manure.

Before proceeding to state the details of the experiment, as furnished by Mr. M'William and Mr. Geddes, the Committee may remark that last season appeared to be very unfavourable to the experiment, from the long continuance of dry weather, and more particularly as it is pretty evident the turnips come away much earlier to which sulphuric acid has been applied, and consequently are sooner affected with drought.

The crops of both gentlemen raised by means of the application of the sulphuric acid were very fair indeed, though it was evident in the fields that the turnips raised from bones continued more vigorous in the tops than those from sulphuric acid and bones, the one having pushed sooner on to maturity than the other. In Mr. M'William's field this was particularly to be remarked, and the crop there raised by bones alone, appeared to have the advantage; but when the experiment came to be proved at the weighing-machine, the difference of produce was very evident.

Mr. M'William, in his report to the Committee, states that on a field of Swedish turnips, he manured very heavily with well-prepared farm-yard manure, and commenced sowing on the 13th of May; that to some parts of the field he applied, in addition, 12 bushels of bones per acre; to other parts a proportion of guano, and to $2\frac{1}{2}$ acres a solution of sulphuric acid and bone-dust, at the rate of 2 bushels of bones and 46 lbs. of sulphuric acid. These applications had an advantage in the crop, over what was manured only; but from the great quantity of manure applied over the field, this was not considered to be a fair test of the different applications.

The applications were fairly tested on another field, which Mr. M'William states was

“ rather favourable for turnips, had carried a crop of wheat, which was well manured after a two-years' ley. The wheat-stubble was trenched-ploughed with three horses, and, in spring, treated in the usual way.

" Drilling and sowing of turnips commenced on the 12th of June; the drills were deeply formed and slightly harrowed down, and bone-dust (no drill used) at the rate of 20 bushels per acre sown with the hand, previously watered to encourage fermentation. The sowing was continued on the 22nd. On the 21st I had a bushel of the finest dust sifted out, which was mixed with 29 lbs. of sulphuric acid, previously diluted with 56 lbs. of water, and having stood for twenty-four hours, was further diluted with about 1600 lbs. of water, or 160 gallons, and applied with a watering-pan to the drills harrowed down as before mentioned, and sown on the 22nd. This quantity was applied to fifteen drills, containing 1 rood 6 falls, Scots. In this case 6 lbs. more sulphuric acid were used to the bushel of dust than on former applications, and with advantage, reducing the bones more effectually. On the same day, to eighteen drills, containing 1 rood 15 falls, I applied 1½ cwt. guano, mixed up the day previous with 3 bushels of bone-dust and 5 of saw-dust, in all 10 bushels of mixture, intended for ½ an acre; but being smaller than bone-dust, it went through the hand faster, and only went over 1 rood and 15 falls. On the same day, and immediately adjoining, bone-dust was sown, at the former rate of 20 bushels per-acre. On the 23rd I sowed thirty drills, containing 2 roods 11 falls, with 10 bushels of bone-dust, applying in the morning to the bones 38 lbs. of sulphuric acid diluted with 63 lbs. of water; and on the same day bone-dust was sown in the usual way."

" The turnips sown with bones on the 12th of June came to the hoe on the 12th of July. The fifteen drills sown on the 22nd with the solution of sulphuric acid and bones were equal in every respect, and came to the hoe at the same time, though ten days later in sowing. The eighteen drills sown with guano and bones were four days later than the sulphuric, but six days before the bone-dust. The thirty drills sown with 10 bushels of bone-dust and sulphuric acid gained six days in hoeing on those sown the same day with bone-dust alone. At this period the difference betwixt the applications and the bone-dust sown in the usual way was most marked, and could be observed at a considerable distance, showing decidedly the great advantage in seasons when the turnip-fly prevails. The turnips were all hoed as equal as possible, and treated in every way the same. On the morning of 12th of November, the day of inspection by the committee, part of two drills of each experiment, measuring 335 imperial links, or 73¾ yards in length, was pulled, carefully topped and tailed, and carted home separately, and correctly weighed—the result of which was as follows :—

	Tons. Cwt. Lbs.			Tons. Cwt. Lbs.		
1st. The turnips raised with the solution of sulphuric acid and bone-dust weighed 6 cwt. 19 lbs., equal to				17	4	15
Or per imperial acre	13	12	97			
2nd. That with guano and bones, 6 cwt. 8 lbs.				16	18	74
Or per imperial acre	13	8	59			
3rd. That with 20 bushels of bone-dust, 4 cwt. 42 lbs.				12	4	3
Or per imperial acre	9	13	55			
4th. The bone-dust watered with the solution of sulphuric acid, 4 cwt. 75 lbs.				13	0	52
Or per imperial acre	10	16	58			

"The turnips were all of the same description, green-topped yellow. The soil was equal. No farm-yard manure was applied to any part of the field.

"The difference of expense thus, per Scots acre:—

	£.	s.	d.	£.	s.	d.
1st. Solution of bone-dust and acid, sifted out, at 3s. 6d., 14s.; 116 lbs. of sulphuric acid at 1½d., 14s. 6d.					1	8 0
Or per imperial acre				1	2 7	
2nd. Guano and bone-dust, 1½ cwt. at 20s., 25s.; 3 bushels of bone-dust, at 3s. 3d., 9s. 9d.—1l. 14s. 9d., applied to 1 rood 16 falls, in place of ½ an acre as intended, when the expense per acre would have been 3l. 9s. 6d.; but as applied					5	1 1
Or per imperial acre				4	0 1½	
3rd. Twenty bushels of bones					3	3 0
Or per imperial acre				2	9 11½	
4th. Ditto, with addition of 76 lbs. of sulphuric acid					3	12 6
Or per imperial acre				2	17 5½	

"The turnips raised with the solution of sulphuric acid and bone-dust kept in advance, and came earlier to maturity, as also those with the guano. The early season was against them in this respect, as they were checked in growth much sooner than in an ordinary season. Had this not been the case, they would have gained more advantage in point of weight over the others than they have done.

"To a different part of the same field, but a few days later in sowing, I sowed green-topped white turnips; to a part of these I applied 10 bushels of bone-dust per acre, dibbled in. These came up a very unequal braird, and were afterwards thin on the ground. To 8½ drills I applied ¾ cwt. of guano, mixed with 1½ bushel of wood-ashes and 2½ bushels of saw-dust, in all, of mixture 5 bushels, intended for ½ an acre, but only went over 1 rood 23 falls. The turnips after this were a fair crop, and superior to that with the bones dibbled. The rate per acre of guano was 213 lbs., value 38s., exclusive of wood-ashes and saw-dust, and value of bone-dust 32s. 6d. per acre. No comparison was made as to weight.

"To part of another field of poor thin soil, half manure was applied, and watered in the drills with a solution of bone-dust and acid, prepared as before, at the rate of 2 bushels of dust and 46 lbs. of sulphuric acid per acre, diluted with 112 lbs. of water, and afterwards reduced to the proper quantity. The turnips were sown on the 2nd of June, white globe and green top, in two alternate drills, intended for early eating off, one half to be pulled. The crop, considering the soil, was good; but the dry early season was much against it. The other part of this field was sown on the 28th of June in the same way, and the same description of turnips. These came most rapidly on for the hoe, and were a good crop for the quality of the ground. For poor thin land I would decidedly consider this mode of application the most advantageous. There were only three drills left without the solution being applied to, and these were very inferior."

Mr. Geddes, in his statement furnished the Committee, gives an "account and result of experiments made on the growing of

turnips by three different modes, on the farm of Orbliston, season 1842:—

“ I may premise what I intend to be a concise and ample report of these experiments, by stating that they were made on light turnip-soil, by no means in high condition, and that in naming the acre I mean the imperial or standard.

“ On the 1st of June the third part of an acre was measured off, and next day thrown up into drills, formed deep, and made 28 inches wide. On the same day a bushel of bones was sifted fine from a large heap of mixed drill and dust; the bones were then weighed, and found to be 45 lbs.; they were then placed in a large box, 22½ lbs. of sulphuric acid, being one-half the weight of the bone-dust, were then weighed out and applied to the bone-dust, and immediately afterwards were added 67½ lbs. of water, or three times the weight of the sulphuric acid. The whole was then stirred about, and allowed to remain twenty-four hours, by which time the mixture had obtained the consistency of fine gruel, and the particles of bones were completely dissolved, with few exceptions. At this time were added 2200 lbs. of water, or 100 times the weight of the sulphuric acid; the whole mixture then appeared like dirty water, and was carried to the fields. The expense standing thus:—

	£.	s.	d.
1 bushel of sifted bones, at 3s. 6d.	0	3	6
22 lbs. of sulphuric acid, at 1½d. per lb.	0	2	4
	<hr/>		
	£0	5	10

Or per acre 17s. 6d.

The drills were then harrowed down by a single streak; the mixture drawn off the box, and applied by a watering-pan along the bottom of the drills, then covered in the usual manner, and immediately sown with Dale's Hybrid Turnips.

“ On the same day another third of an acre was measured off, and drilled up 28 inches wide; and to this were applied 5 cart-loads of farm-yard manure, properly prepared, and 5 bushels of bones, half dust and half drill, again covered in, sown with the same kind of turnips in the usual mode. The expense standing as follows:—

	£.	s.	d.
5 cart-loads of manure, at 1s. 8d. per load	0	8	4
5 bushels of dust and drill-bones, at 3s. 2d.	0	15	10
	<hr/>		
	£1	4	2

Or 3l. 12s. 6d. per acre.

“ Likewise, on the same day was measured off one-third of an acre, and drilled up 28 inches wide; to this were given 4 bushels of bones, half drill and half dust, dibbled in, and the seed dropped in immediately over the bones, being the same kind of turnips as the other—the expense being 4 bushels of bones at 3s. 2d.—12s. 8d.; or 1l. 18s. per acre. These experiments were all made on the same field, and nearly adjoining each other.

"At the time these turnips were sown, the weather was extremely favourable for a rapid braird. The sulphuric acid turnips, however, made their appearance first, then came the dung and bones, and lastly the bones alone. The rapidity of growth of the sulphuric acid continued to be maintained over the others, and they came to the thinning seven days before the dung and bones, and ten before the bones singly. The braird of all was healthy and vigorous; but the superiority of the sulphuric acid was visible at a great distance. The season continued very dry and warm, and all the kinds pushed on *too* rapidly to maturity; they stopped growing for want of moisture, and came, as it were, to a premature ripeness, especially the sulphuric acid turnips, which were too far gone to be benefited when the rain did come, and which fact, I am inclined to think, tells against the weight of the sulphuric acid turnips in an unfavourable manner, as compared with the others.

"On the 10th of November 200 yards of a drill of each kind was pulled, and, being carefully divested of leaves and roots, the bulbs were on the same day accurately weighed, and the result found to be as follows :—

- 1st. Two hundred yards of sulphuric acid and bone-dust turnips, at an expense of 17s. 6d. per acre, weighed 972 lbs., or 13 tons 10 cwt. 21 6-70th lbs. per acre.
- 2nd. Dung and bone-dust, at an expense of 3l. 12s. 6d. per acre, weighed 1005 lbs., or 13 tons 19 cwt. 21 6-7th lbs. per acre.
- 3rd. Bones singly, at an expense of 38s. per acre, weighed 825 lbs., or 11 tons 9 cwt. 21 5-7th lbs. per acre.

"It occurs to me that in enumerating the advantages gained by the use of the sulphuric acid, independent of the difference of expense, that of pushing the braird so rapidly away, by which it completely distances the fly, and that of enabling the farmer to sow his turnips ten days later, may be considered as great over the old modes.

"I watered with the acid several drills through my other turnip-fields, and on all observed an advantage. I likewise tried drills here and there through those fields with the same proportion of bones and acid as mentioned, and the result in all the cases was similar to those detailed."

With these minute and successful results of the experiments tried, the Committee cannot doubt but in another season the same experiments will be widely and extensively followed up.

(Signed)

PETER BROWN.
A. LUMSDEN.
JOHN SMITH.
JOHN STEPHEN.
JNO. LAWSON.

XIII.—*On the Rotations of Crops on Heavy Lands.*

By WILLIAM STACE.

PRIZE ESSAY.

HAVING had considerable experience in the cultivation of heavy soils, and having for many years turned my attention particularly to the selection of such crops as are calculated to render heavy soils more friable, by the mechanical action of their roots, and having by that means succeeded in growing such root crops as are usually grown only on lighter soils, I respond to the invitation of the Royal Agricultural Society of England, and proceed to give some account of the rotation of crops which I think best suited for heavy lands, and calculated to bring such lands more nearly on an equality with those of a more friable texture than they at present are in the maintenance of stock.

I am aware that it would be impossible to propose any rotation of crops that would be suited to all heavy soils; nor do I pretend to be able to say what rotation would be best suited to each variety of soils termed heavy; so infinite is that variety in tenacity and quality, that I believe only those who cultivate them are able to determine, in every case, what course of crops is the most profitable to be adopted.

Therefore, although I propose with some confidence a rotation which I believe to be well suited to most heavy soils, yet I readily admit that there are many heavy soils to which it is not suited, and that certain localities, or various circumstances, may render its adoption on some others inadvisable.

As the object in the following rotation is to obtain from heavy soils *profitably* that which has generally been yielded only by light soils, I have introduced such crops in the rotations as, by the mechanical action of their roots on the soil, have the greatest tendency to ameliorate it and render it more friable: such are tares, winter-beans, and clover.

Another motive to the selection of tares and winter-beans is, that the cultivation proper for them is required at the time of year when the treading of horses is least injurious, and when the turning up the soil and exposing it to the action of the atmosphere is most beneficial, so that the cultivation for them, as well as the crops themselves, tend to the desired effect—that of rendering lighter the soil on which they grow.

The following is the course I propose:—

First year—Winter tares, to be fed off by sheep on the land, followed by turnips and rape; the rape, and also part of the turnips, to be fed off by sheep; the remainder to be carried off and eaten in the yards.

Second year—Wheat.

Third year—Clover, to be cut for hay, on one half, and trefoil and rye-grass mixed on the other half, to be fed off by sheep in the Spring, and followed by Spring tares, also to be fed off by sheep.

Fourth year—Wheat.

Fifth year—Winter-beans.

This ends the course, excepting that in the next course the clover takes the place of the trefoil and rye-grass in the former course, and the trefoil and rye-grass that of the clover, by which arrangement the land bears clover only once in ten years.

By this system every hundred acres of arable land would produce annually forty acres of wheat, twenty acres of beans, thirty acres of tares, twenty acres of turnips, ten acres of clover, to be mown twice, and ten acres of trefoil and rye-grass, to be fed a few weeks in the spring.

In order to point out the fitness of the above rotation for the object intended, it will be necessary to enter into some particulars respecting the cultivation best suited for some of the crops.

Preparation for the winter tare-crop should commence before the beans are carried from the field. My practice is to cut them and bind them in sheaves at the end of July (for *winter* beans will ripen thus early); I then clear a space wide enough for the ploughs to begin, and place the beans on the ploughed land as the ploughs proceed, and then, by arranging them in straight rows across the field, the land may be harrowed and rolled before the beans are ready to be carried, and another ploughing may be given immediately after, followed by the necessary harrowings and rollings. The field should then be manured with rough unfermented dung: the less the manure is decomposed when applied for this crop, the lighter and drier will the land be in the spring, after the tares are fed off, and the greater will be its effect on the following turnip crop. The tares should be sown for successional crops from the first week in September to the end of October: a small portion of those sown first should have a little rye mixed with the tares—about one bushel of rye and two bushels of tares per acre would be sufficient: this would be ready for the sheep to begin early in the spring, and should be followed by wheat and tares, in the same proportions. A larger quantity of this may be sown than of the rye and tares, as the wheat continues longer in perfection, as food for sheep, when mixed with tares than with rye; and I have found it prove a very wholesome and abundant crop—one acre frequently producing sufficient food for two hundred sheep for a week, in the month of May. The winter tares should then be sown in the following order:—

In the first week of September a small portion should be sown with rye and tares, and a larger portion with wheat and tares.

At the end of September one-third of the remainder should be sown with two-and-a-half bushels of tares per acre.

In the middle of October another third should be sown with the same quantity per acre; and

The last sowing should be finished at the end of October, with three bushels per acre.

When I begin to feed tares in the spring I keep the sheep entirely upon them; the fold is moved twice in the day, and the tares are cut and put in moveable cribs. As fast as the land is cleared of tares it should, with the greatest expedition that the weather will admit of, be prepared for turnips; for even under the favourable circumstances of the previous cultivation and manure, heavy land cannot be well worked in the spring unless it be sufficiently dry; and from my own experience I have found that heavy land will become earlier dry, and more friable, after bearing a crop of tares than after a winter fallow.

The first turnips that are sown (at the end of May) should be an early sort, to be fed on land before the rape is ready; then all the land that can be prepared before the middle of June should be sown with Swede turnips, to be carried off for winter food in the yards; then all that can be prepared by the end of June should be sown with some sort better suited for late sowing; these may either be fed on the land or carted off; the remainder of the tare-ground should be sown with rape, to be fed on the land in the autumn, after the early turnips. As the turnips and rape are cleared from the field, wheat should be immediately sown, and on one half the wheat, clover should be sown in the spring. The common objection to sowing clover in wheat does not apply when wheat is sown after turnips, as the wheat is not likely to be laid by an over luxuriance of straw, though I have always found it a good yielding crop. The other half should be sown with trefoil and rye-grass; and although it may appear that this crop is sacrificed by being ploughed up early in the following spring, to make room for the more valuable one of spring tares, yet it will be found to produce a good quantity of food in the stubble after harvest, and very nutritious and wholesome food for sheep early in the spring. As soon as the land is sufficiently dry in the spring, a small portion of tares should be sown, and the rest in succession till the beginning of May. In feeding these tares off with sheep the land will be manured for the following wheat crop; and the clover ley may be manured by folding sheep on it at night, whilst they are eating the turnips and rape, as the land on which they grow has been sufficiently manured before. Wheat follows; and after that the land should be ploughed and the winter-beans drilled in, in October, at the rate of two-and-a-half bushels per acre. The rows should be sufficiently far apart

to admit the horse-hoe, and the beans should be kept as clean as possible. The winter-beans coming early to harvest are generally carried before the haulm is much injured by the weather, consequently sheep will eat it (*i.e.* the haulm) with avidity, if given to them in a yard at some part of the day whilst feeding off turnips and rape: this I have practised for some years, and found it particularly wholesome for the sheep.

I must be allowed to repeat, that in this rotation such crops have been excluded as require the land to be ploughed early in the spring, when it is most injured by the treading of cattle, such as oats and spring beans; and such are introduced as are least exhausting to the soil and best calculated to render it more friable, such as tares, clover, and beans; and my own experience assures me that by it is afforded such an abundance of food for cattle as will insure an ample supply of manure to keep up, or rather increase the fertility of the soil.

Berwick, near Lewes, Sussex.

XIV.—Report to the Honourable Robert Clive, M.P., on his Improvements by Draining and Subsoil-Ploughing. By RICHARD WHITE.

[Continued from Journal, vol. ii. p. 353.]

SIR,—IN following up the continuation of my report of thorough-draining and subsoil-ploughing, together with the crops upon the farm in your own occupation from October, 1841, I beg leave to state that the draining and subsoil-ploughing are first stated and added to the former abstract; and that other remarks follow, beginning with the number and acreage of each piece.

A. R. P.		£. s. d.		
No. 10.—9 0 8 . 9660 yards. This field is a stiff clay loam, and much alike in the surface and subsoil; the drains are 15 feet apart: a two-years' ley. Drained in the spring of 1841, broken up and summer-fallowed, a little manure applied, and wheat sown in autumn. For cutting open, putting in the stone, breaking, and filling in the drains, at 1d. per yard .				
Raising 500 yards of stone at 5d. per yard .		41	10	0
Carting ditto to drains about $\frac{1}{4}$ of mile, 5 horses, 10 days, at 15s. per day .		0	10	8
Filling 500 yards of stone into carts, at $1\frac{1}{4}$ d. .		7	10	0
Subsoil-ploughing, 9 acres, at 21s. per acre .		2	14	2
		9	9	0
		<hr/>		
		£71	11	2
		<hr/>		
Per acre .		£7	14	6

Upon this field the wheat was sown in October, 1841, (a very wet time;) it came up well, although the ground was very wet: the drains had their full effect, and the wheat-crop at harvest was thin, but regular, and I think will yield about 20 bushels per acre.

A. R. P.			£.	s.	d.
No. 11.—6 2 9..4624 yards. This field is a mixed soil of clay loam, and some very inferior; and the substratum is similar. Drained in January, 1841. A ley three years. Ploughed and sown with oats in April. The drains are 21 and 24 feet apart; the stone got in the field. Raising the stone, cutting the drains, wheeling the stone thereto, breaking, and filling in 4624 yards at 1½ <i>d.</i> per yard					
				28	18 0
Subsoil-ploughing 6 <i>A.</i> 2 <i>R.</i> 9 <i>P.</i> at 21 <i>s.</i> per acre				6	16 6
			£35	14	6
Per acre			£5	10	0

A. R. P.			£.	s.	d.
No. 12.—9 2 24..8474 yards. This is a poor, impoverished piece of land, varying much in surface and substratum, some parts a clay with a white and yellow tinge, other parts clay loam, with a mixture of stone. A three-years' ley, drained in January, 1842, and sown with oats in April. The drains are 15 feet apart. Stone got in the field for 968 yards, getting the stone, wheeling to drains, cutting, laying, &c., at 1½ <i>d.</i> per yard					
				6	1 0
Cutting open and laying 7506 yards, breaking stone, and filling in at 1 <i>d.</i> per yard				31	5 6
Carting 375 loads of stones to drains, 5 horses, 10 days, at 15 <i>s.</i> per day				7	10 0
Raising 375 loads of stone at 6 <i>d.</i> per load				9	7 0
Filling ditto into carts, at 1½ <i>d.</i> per load				1	19 0
Subsoil-ploughing 9 <i>A.</i> 2 <i>R.</i> , at 21 <i>s.</i>				9	19 6
			£63	2	0
Per acre			£6	19	0

ABSTRACT OF FORMER REPORT. *Brought forward.*

	A.	R.	P.	Yards.	£.	s.	d.
To No. 9 inclusive	88	2	9	60,032	544	17	3
„ 10	9	0	8	9,960	71	11	2
„ 11	6	2	9	4,624	35	14	6
„ 12	9	2	24	8,474	66	2	0
	113	3	10	83,090	718	4	11
Average expense per acre					£6	7	0

The above 113 acres comprise the whole of the arable land which has been under the plough for many years. The old pasture-land will nearly all require to be drained, and undergo two or three courses of tillage, in order to improve the herbage. Draining is now done upon a part of the old pasture, and ploughed up for oats, and preparation is making for a good deal more to be done this season. The whole has been laid down in a very bad state, with a very uneven surface, and I do not see how this part of the farm is to be made useful in any other way; and I propose going through the whole as it comes in course, resting the old tillage part of the farm till all is accomplished. The meadow-land is in a better state; the surface is even. The part irrigated is much improved, and a good deal of draining with top-dressing has been done with great effect. A more detailed account is intended to be given of the meadow and pasture part of the farm in a future report.

I shall now confine myself to the crops, and effect of what has been done upon the arable part, the numbers in the abstract of 10, 11, and 12 I have added to my former report, and containing particulars of the expense of draining and subsoil-ploughing, showing the average per acre upon the whole, beginning with No. 1, and so proceed with the whole in succession. I shall also forward you with this a particular of the result of the crop of barley this year, after turnips, being the experiment of 1 acre each from four different sorts of manures (viz., Poittevin and Co.'s disinfecting, Ludlow street-sweepings, bones, and fold-yard manure). The quantity of barley from each acre will show a great increase of produce, and I beg to add that this experiment has been carried on with great exactness; and with regard to the other crops I will give you estimated quantities in their course, commencing with

No. 1. Wheat 1841, a good even crop all through; the produce per acre 26 bushels of best and 1 bushel of tail; after the wheat this field was ploughed in January, 1842, from 10 to 12 inches deep; in April and May it was worked with the Twins, with harrowing and rolling, was made perfectly clean and fine without further ploughing. The beginning of June, Swede turnips were sown 27 inches apart, and 8 inches in the row, with 10 cwt. of bones and about 6 tons of fold-yard manure to an acre: the turnips very good; one-half are drawn off for cattle, and the sheep follow by eating the other half regularly over the field, so that the land has an equal benefit from the sheep.

No. 2. In this field the experiment of the different manures is carried on, of which I give you a detailed account in a separate report; therefore I shall not say more than that the barley was equally good over the field, and will, I think, turn out to be 40

bushels per acre; the clover has come well, and the land is in an excellent state.

No. 3. In wheat 1841, the crop even, and in every respect similar to No. 1, with 26 bushels per acre; the land was ploughed and worked with the same application of manures as No. 1, with the same success.

No. 4. Wheat 1842, after clover, with the exception of about 3 acres, which was much thinned by the slug as it came up; the rest of the field was a heavy crop; it lay in a slanting direction, and will not in consequence, I think, yield so well; I estimate it to be 26 bushels per acre. The field was ploughed a foot deep in November last, preparatory for turnips, 1843: it will be in a fine state.

No. 5. The part drained and subsoil-ploughed; barley 1841, very good, the average per acre was 30 bushels. Clover grazed, 1842, exceedingly good; to lay another year.

No. 6. Barley 1841, the crop very good; produce per acre 30 bushels. Clover, 1842, mown, and a very heavy crop; wheat sown. This field is in a high state of cultivation.

No. 7. Barley 1841, the crop very good; average produce per acre 30 bushels. Clover, 1842, a strong crop mown, now sown with wheat, which the slug attacked as it came up, and, I fear, has thinned the stock. Swede turnip-tops were scattered over the field, which they took to feed upon, and upwards of half a bushel of slugs were collected. I still think there is plant for a crop; the land is in a high state.

No. 8. Turnips 1841, and barley 1842; crop very good, estimated at 40 bushels per acre. Clover and rye-grass sown in the barley, and the stock is good.

No. 9. Drained and subsoil-ploughed, and part of which is dry sound land; turnips 1841, barley 1842; the crop very strong, estimated at 40 bushels per acre. Clover sown, and the stock good; the land in a high state.

No. 10. Wheat 1842; subsoil-ploughed in November and December, preparatory for turnips 1843.

No. 11. Oats 1841, after a three-years' ley; a good crop, drained previous; produce 42 bushels per acre. Turnips 1842 (Scotch yellows), very good; $\frac{1}{2}$ ton of bones and about 6 tons of fold manure to an acre; drilled 27 inches apart, and about one-third of these turnips have been drawn off for the cattle, and the remainder eaten on the ground with sheep. Generally over this field lumps of rock prevail, with many stones, in a stiff soil.

No. 12. Oats 1842, after a three-years' ley; the crop turned out much better than was expected; the produce per acre is 40 bushels. This field now subsoil-ploughed, preparatory for turnips 1843. Coltsfoot and sow-thistle prevail much.

Having given you an account in detail of the crops and state of each field, I have some further remarks to make generally, that the subsoil-ploughing and other deep ploughing have nearly eradicated the coltsfoot, sow-thistle, and common thistle; indeed the whole of the crops are quite free from weed. The success in the increase of produce of every description is very satisfactory; I beg to mention the clover more particularly, because I was repeatedly told the land would not grow clover at the time you took the farm into your own occupation; now the clover has never in any instance failed, but since the operation of thorough-draining, subsoiling, and deep-ploughing has been carried into effect, the clover is more than double the produce, and I have no doubt whatever of its continuing to be so: the root now growing is exceedingly promising.

I have also to remark that the barley is not only more than double in quantity per acre, but its quality much improved; last year and this it is spoken of by the maltsters in the highest terms in the working. I think the average of the crop of this year will be above what I have stated in the experiment.

The wheat-crop is also much increased in quantity per acre: the average of 1841 is as stated, and the crop of 1842, I have no doubt, will turn out well.

The crops of turnips of 1841 and 1842 have been very regular and good, and if the land is now continued to be deep-ploughed and well worked, there is no doubt whatever of continued certain crops. One very important matter I beg to name; that is, the whole of the land that has undergone the operation of thorough-draining, subsoil-ploughing, and deep-ploughing is not only easier worked but is done so at a considerably less expense, the whole having an even surface without furrow or ditch, no time is lost in the ploughing. The great increase of straw is also increasing the manure, which will now allow a good portion to be applied to the meadows, and such land as is intended to be laid down to permanent pasture. The application of bones has greatly assisted in this. I have much satisfaction in stating that there is not the least failure in any part of the draining that has been done: the whole continues to work well.

I have the honour to be, sir,
Your faithful and most obedient humble servant

RICHARD WHITE.

Prior's Hallon, March, 1843.

EXPERIMENT. Barley 1842 (following Turnips 1841.)

Nos. 1, 2, 3, and 4, each containing one acre.

Description of Manure.	No. Bushels of Seed.	When sown.	When cut and carried.	Weight of Straw and Chaff.	Quantity of best Grain.	Quantity of Tail.	Total Quantity.	Observations.
				T. C. Qr. Lbs				
1. Poitteen & Co.'s disinfectant . .	4½	25 Ap.	{ 25 Aug. } { 5 Sept. }	1 8 2 27	42	2½	44½	
2. Ludlow street-scavenging .	4½	Do.	Do.	1 8 2 25	40½	2½	43½	
3. Bones (half-inch)	4½	Do.	Do.	1 7 3 12	40½	2½	43½	Some injury to the crop from an oak-tree.
4. Fold-manure .	4½	Do.	Do	1 7 0 14	40½	3	43½	Do. do. do.

The turnips of 1841 were one half carried off for cattle, and the other half were eaten on the ground by sheep.

XV.—On the Use and Application of Rape-dust. By JOHN HANNAM, North Dighton, Wetherby; Honorary Member of the New York State Agricultural Society.

[Extracted from a Prize Essay of the Wetherby Agricultural Society, "On the Application of Rape-dust and other Hand-tillages," Longman and Co.]

RAPE-dust, the seed of the rape plant after the oil has been extracted from it, is a fertilizer of great value. It contains matters highly essential to the growth of vegetables. Thus, according to the analysis of M. Boussingault ('Annales de Chimie et de Physique,' September, 1841), 8 tons of rape-dust afford as much nitrogen as 100 tons of farm-yard manure. According to Dr. Madden,* it is *greatly superior* to farm-yard manure in soluble organic† matter, *equal* to it in phosphates, and *inferior* to it slightly in saline matters; or, taking all together, that 1 ton of rape-cake equals 18·42‡ tons of farm-yard compost.

From this analysis we should be justified in concluding,—

1st. That rape-dust is a potent fertilizer; for we have in the preceding pages shown that plants require a large portion of vegetable and animal matter to afford a supply of carbon, in the shape of carbonic acid, and of nitrogen, in the shape of ammonia;

* Prize Essays of the Highland Agricultural Society, June, 1842.

† "The constituent parts of plants are of two distinct sorts, organic and inorganic. The organic parts are those which disappear by the action of fire. The inorganic constituents are left in the form of ashes."

‡ My attention has been drawn to an error in this calculation, but I can state from observation that 1 ton of rape-dust is fully equal to 20 tons of common dung.

both of which are evolved during the decomposition of organic substances.

2nd. That rape-dust is most valuable to grain crops: first, because all green crops require a large supply of inorganic matters,* which rape-dust is deficient in, and derive, by their large

* From the following table (compiled by Professor Johnston, 'Lectures on Agricultural Chemistry,' part ii.) it will be seen that the green crops extract from the soil more than double the quantity of inorganic matter required by wheat and barley, and that in these inorganic matters they take up *nine times* as much potash, soda, and lime, and *five times* as much of the phosphoric and sulphuric acids, as the latter.

Table of the Inorganic Matters drawn from the Soil by one Course of Crops on the Four-course System.

	25 Tons of Turnips.	38 Bushels of Barley.		Seeds.		25 Bushels of Wheat.		Total of each Element.
		Grain.	Straw.	Red Clover	Rye Grass	Grain.	Straw.	
				1 Ton.	1 Ton.			
Potash	115.5	5.6	4.5	45.0	28.5	3.3	0.6	233.0 lbs.
Soda	64.3	5.8	1.1	12.0	9.0	3.5	0.9	96.6
Lime	45.8	2.1	12.9	63.0	16.5	1.5	7.2	149.0
Magnesia . . .	15.5	3.6	1.8	7.5	2.0	1.5	1.0	32.9
Alumina	2.2	0.5	3.4	0.3	0.8	0.4	2.7	10.3
Silica	23.6	23.6	90.0	8.0	62.0	6.0	86.0	299.2
Sulphuric acid	49.0	1.2	2.8	10.0	8.0	0.8	1.0	72.8
Phosphoric do.	22.4	4.2	3.7	15.0	0.6	0.6	5.0	51.5
Chlorine	14.5	0.4	1.5	8.0	0.1	0.2	0.9	25.6
Total Ashes in each Crop .	382.8	47.0	121.7	168.8	127.5	17.8	105.3	970.9

To test this, practically, Boussingault "determined the per centage of carbon in the soil, before the experiment was begun, the weight added in the form of manure, the quantity contained in the series of crops raised during an entire rotation, until, in the mode of culture adopted, it was usual to add manure again; and lastly, the proportion remaining on the soil." (*Vide Johnston's Lectures*, part i., p. 219.) By this he found that in a course of—

Potatoes—with manure
Wheat
Clover
Wheat
Oats,

he had given to the soil, in the manure, 2513 lbs. of carbon, and extracted from it in the crops 7544 lbs., leaving a balance of 5031 lbs. of carbon, which must have been extracted from the air, as the soil was left in the same condition at the end of the course of crops that it was at the commencement.

From this it will be evident that green crops, by their large surface of leaves, &c., possess a great power of attraction for the atmospheric gases.—*The Author.*

system of leaves, a greater supply of food from the air than the grain crops; secondly, because all plants require a supply of nitrogen to perfect their seed,* which nitrogen rape-dust possesses in an extremely large proportion.

Srd. That rape-dust is extremely quick in its effects, and, consequently, not lasting, because it contains such a large proportion of soluble organic matter, and so little of the earthy inorganic substances (or, more plainly, so little ashes), that fermentation and putrefaction take place immediately; whence its carbonic acid and ammonia are supplied to the roots of the plant in large proportions at the commencement of its growth, and, if not taken up, escape into the atmosphere. In corroboration of this tendency to act quickly, it may be stated that out of 100 parts of rape-dust Dr. Madden found 24·7 (or nearly $\frac{1}{4}$ of the whole) soluble in cold water, while "the first waters were of a pale yellow colour, whereas the latter were *red*; proving that the tendency to decomposition was so strong, that it had commenced during the process of the analysis." (Vide 'Prize Essays of the Highland Society,' June, 1842, p. 529.)

These, then, are the conclusions which the established principles of vegetable chemistry induce us to come to, from a consideration of the constituent parts of rape-dust. *Practical experience teaches us to arrive at the same result.*

Thus I would point to its extensive, and I may almost say universal, application as a proof of its *general efficiency* as a fertilizer.†

* The seed of plants is, in all instances, the most highly azotized portion. (Dr. Madden, on *Principles of Vegetable Physiology*.) Thus the grain of wheat (according to Boussingault) contains 2·13 per cent. of nitrogen, and the straw only ·20.

The quantity of nitrogen in the seed varies also, according to the quantity of nitrogen contained in, or the ammonia evolved by, the manure in the soil. Thus *Hermbsstaedt* found that wheat grown *without manure* gave 9·2 per cent. gluten (containing a large per centage of nitrogen);

Wheat with vegetable manure	.	.	9·6
„ cow-dung	.	.	12·0
„ sheep-dung	.	.	32·9
„ night-soil	.	.	33·14

It is common to estimate the nutritious quality of flour or grain by its amount of gluten.

† I find from authentic sources, that, however general the efficiency of rape-dust as a manure may be, I have no right to assert that a knowledge of its value is equally general; for it is surmised in our Journal (vol. iii. p. 210) that the use of rape-dust is only established in Nottinghamshire, Yorkshire, and Lincolnshire, while in some of the southern counties its use is unknown. Although we have the advantage of the

In illustration of its *particular value* as a manure for *grain crops*, I need only refer to its common use for such crops in many parts of England. A ride in the neighbourhood of Wetherby will convince the most sceptical of its efficacy, if they observe the crops produced on many soils by the application of from 8 to 16 bushels per acre.

The quick effect of rape-dust upon the growing crop, and its speedy escape from the soil, are matters which the experience of every farmer will have taught him.

From this view of the elements of rape-dust, and of its general operation, we deduce the following practical conclusions to regulate its application with respect to corn :—

1st. That rape-dust, being so beneficial to the growth of grain in general, is most marked in its effects *upon thin, poor soils*.

2nd. That it does not operate so well in a dry season as in a moist one.

3rd. That it is most *certain* in its effects upon the winter-sown wheat crops ; but, *in favourable seasons*, most remunerative on the spring crops.

4th. That it answers best on strong soils for the wheat crop.

5th. That it is not judicious to apply large quantities at one time.

6th. That it is necessary, after using rape-dust for several rotations, to apply a dressing of saline and earthy matters.

These are matters of fact, as well as of reason. The explanation we would offer is—

1st. That the marked effect of rape-dust upon thin, poor soils, is to be attributed to the general deficiency of these soils in the vegetable and animal matters necessary to supply the plant with carbonic acid and ammonia ; which matters rape-dust, as we have shown, contains. Again, these soils often possess a large share of the mineral constituents of plants, in which matters rape-dust is deficient. So that the capabilities of the manure are adapted to the wants of the soil.

2nd. That it does not act so well in a droughty as in a moist season is not strange.* No manure can operate well—no crop

southerns in this point, we must not, however, be vain of our knowledge ; for the writer at the same time says, “ as another instance of the local prevalence of manures, woollen rags may be cited, *which are the only hand-tillage familiarly known to farmers in my own neighbourhood*. Mr. Hannam states, ‘ 20,000 tons of rags are *said to be* used annually by the farmers of Kent, Sussex, Oxford, and Berkshire.’ ”—*The Author*.

* The rule applies to guano and gypsum ; thus we are told that the natives of Peru irrigate the soil after an application of guano. As to

can flourish—without a due supply of atmospheric moisture. The necessity for a supply of oxygen and hydrogen explains this. To manures of an oily nature, this supply of moisture, experience, as in the case of rape-dust, has proved to be highly necessary. In explanation, it should be remembered that carbonic acid, evolved during vegetable decomposition—that ammonia, given off during the decay of animal matter—and the carbonate of ammonia, formed by the combination of these two gases, are all soluble; and also that plants absorb a large proportion of these gases (carbonic acid and ammonia) in a state of solution, in which condition they lose much of their tendency to escape in the gaseous form; hence, during showery seasons, much of the ammonia and carbonic acid of rape-dust, which in dry weather rises into the atmosphere, is washed to the root of the plant; which, owing to its liberal supply of moisture, is in a healthy condition; and can, consequently, assimilate a larger portion of food. In drought the reverse is the case; being poorly supplied with water, the plant languishes, and can appropriate but a slight portion of the nutritive gases, which, when not in solution or combination, quickly escape.

3rd. That rape-dust is most *certain* in its effects when applied to the winter-sown wheat is explained by the fact, that there is *never any deficiency of moisture*, which it requires, as we have seen already, and that it acts quickly and pushes on the growth of the young plant; by which means it is better able to bear the severity of winter. That in favourable seasons—that is, when the germinating seed *is supplied with moisture* (a circumstance which is uncertain)—the return for the application of rape-dust should be most remunerative upon *spring* crops, is explained by the fact, that as there is no cessation of vegetation after the plant appears, the nutritive gases are assimilated as soon as they are given off. And as there is no waste of these, as in wheat during winter, when the plant cannot appropriate it, *less* tillage has an *equal* effect—equal tillage a greater. This, of course, depends entirely on the season.

4th. That rape-dust should succeed better for the wheat crop upon strong land is explained by the fact that the soil is not so permeable to the atmosphere as that of a sandy or calcareous nature; hence a much less portion of the carbonic and ammoniacal gases of the tillage escape during winter, and at the same time the active putrefactive fermentation of the rape-dust causes a disintegration or pulverization of the soil round the roots of the

gypsum, the great difficulty with which it is dissolved explains the fact.
—*The Author.*

plant,—an operation of greater value to stiff soils than to free ones.*

5th. That we should not apply large quantities of rape-dust at a time, because the active decomposition may, in such case, destroy the germ of the seed, or cause the produce to yield a coarse and light-weighting sample. The effect of young plants being too largely supplied with rich organic manure is well known. The plant is stimulated to an increased action at one time, which the other matters in the soil cannot maintain; and the consequence is that the seed is deficient in some of its constituent elements, and the straw soft and unproductive.

The case instanced by Professor Liebig, of a vineyard having been thus stimulated by the action of organic matter, is an illustration of the principle.†

* Moreover, strong soils are naturally the best wheat soils, and will make the most sure return for any extra application on the wheat crop.

Again, we have shown that plants require a liberal supply of azote or nitrogen to perfect the seed; now wheat requires more than either barley or oats; all of them, however, require it at the latter stages of their growth, so that the fact that decomposition goes on more slowly in clay, and that consequently the nitrogen of the manure will not escape so quickly, is another reason why rape-dust seems most efficacious for wheat on stiff soils.

Dr. Madden, in his excellent essay 'On the Application of the Principles of Vegetable Physiology and Chemistry to Agriculture,' uses this argument as one of the *probabilities* why wheat seems to require a clay soil. If, however, the retention of azote be, in this case, one *probable* explanation, it appears to be a *positive* one why rape-dust should answer best for wheat on such soils, when it is considered that, owing to its tendency to decomposition, the azote which it contains is so liable to be *quickly* evolved.

† A case in point occurred last year, on the farm of a relative of mine. On a very hungry limestone soil, he drilled barley with from 8 to 12 bushels of rape-dust per acre. The field had grown turnips the preceding year, and the crop had been consumed by sheep on the land during the winter. On the brows of the hills, where the magnesian marl is not more than two inches from the surface, he spread an *extra* quantity of rape-dust from the hand. Throughout the spring, and the summer, the crop looked well generally, but the brows of the hills presented a most luxuriant appearance, being several shades darker in colour, and much longer, than the other parts of the field. In the autumn, however, it was discovered that the promising prospects were not to be realized. The supply of organic matter had been so great that it had forced the growth at a quicker rate than the soil was able to supply the other requisite inorganic matters; the consequence was, that the straw was so soft that it was not able to bear its own weight. Long before harvest it lodged on the ground;

6th. That it is necessary to apply saline and earthy matters to soils, after a course of rape-dust, is on the principle that we cannot maintain fertility without returning to the earth all that we have taken from it. And, in a course of crops, we take away many *earthy* and *saline* substances, while we return *little of the former*, and *scarcely any of the latter*, when we apply rape-dust. When we use bones, they return earthy phosphates, &c. ; but it is still necessary that the saline matters should be restored. Practical experience has fully proved to the writer the advantage of such a course during the present year. *Four* separate applications upon land in this condition have all more than equalled my anticipations.* The sample will in some cases be as much improved by the application as the gross produce is increased.

the ears were badly fed, and the weather discoloured them, so that when thrashed it was found to be deficient both in quality and quantity.

The common explanation offered by most, that "there was more straw than the land could bear," had some truth in it, though not sufficient to justify the conclusion which is often drawn in such cases, "that, manure as you will, you can only get a *certain* quantity of corn;" and that "there is no use in manuring so hard; for if you plough and sow your land properly, in good seasons, and give it a fair quantity of manure, so as to keep it always in the same heart, you will grow as much as it is possible for the soil to produce."

It is true that in the above case there was more straw than the land could bear; had that soil, however, been as rich in the other elements of nutrition as in those supplied by rape-dust, it would have properly matured the crop. It is also true that there are certain limits to the crops we can produce, but the whereabouts of those limits, in my opinion, are *uncertain*. It is also true, that if we cultivate a soil in the manner spoken of, we may ensure its producing a fair amount of produce; and by giving it a larger share of one sort of manure, or by changing one part of our system, we may produce no increase of crop; yet, from this we are not to conclude that it will produce no more. We have perhaps only supplied one condition essential to further fertility, and we must endeavour to supply all. It is useless to apply steam to a carriage, unless we give it wheels; but it is *also* necessary that many other pieces of mechanism should be employed before we can travel at all; before, however, we can say that we can travel as fast as it is possible for us or any others, we must be *certain* that every piece of the machinery is *perfect* in relative size, nature, and make, and that everything is beyond future improvement. So, before we say that we can grow no more, let us ask ourselves if every element or circumstance which the plant requires is in the soil, or ensured by our management.

* A top-dressing of 4 cwt. of salt per acre, at a cost of 8s., gave an increase of barley of 229 sheaves per acre, in my experiments last year. The soil had been subject to a long course of rape-dust tilling for the barley and wheat crops. Upon soil of a similar nature, the *same* application gave an increase of 128 sheaves of oats per acre. The grain was

Having now seen the nature, efficacy, and operation of rape-dust as a fertilizer, we come to consider the various methods of applying it.

The importance of the question is evident. Our success in any matter depends not more upon the means we employ, than upon the manner in which we use those means.

The customary methods of applying rape-dust, though varied in detail, are *but two in principle*. The principle of the one is to spread the matters applied to the soil over the whole surface; this is the broad-cast system. The principle of the other method is to place the seed and manure in straight rows, or drills, at a regular depth and at a regular distance from each other; this is the drill method.

Under the *broad-cast system* the rape-dust is applied as a top-dressing, upon the level surface before the seed is drilled, or upon the furrow before the grain is sown by the hand. By the *drill method* the tillage is deposited below the grain, and at the same time.

There are certain other methods of applying rape-dust, &c.; but they cannot be termed *systems*, being merely special modifications of one or both of the above, and only used in *special cases*.

Of the two great systems, the opinion of the writer is that the drill method has many and decided advantages. In saying this, he can claim no credit. At a time when the system has become part and parcel of the four-course husbandry, and in a neighbourhood where it is employed so extensively, it would be impossible, seeing its beneficial operation, to entertain a different opinion. At the same time there are those to whom this sort of testimony is valueless. Some regard *all custom* as doubtful until its advantages are shown to depend on rational principles; and others think no customs good but their own. To these, then, it is necessary to show that the advantages we claim for the drill method are as explicable by reason as by fact.

The advantages for which we contend involve a *saving in the cost*, and a *gain in the quantity*, of produce.

Thus, by using rape-dust upon the broad-cast system, as a top-dressing, a great portion of its nutritive gases is wasted in the atmosphere, owing to the quick decomposition which takes place. By spreading it over the broad surface, before the seed is drilled, a loss arises from the same cause; for, as the tillage is not in immediate proximity with the seed, a portion of the ammonia and carbonic acid given off during its quick fermentation is ab-

ripe much earlier, in both cases, than that which was undressed: the straw, also, was not so soft, and the stubble much whiter.

sorbed by the weeds, or escapes into the air, before the young plant can send its fibres in search of it. An instance of the rapidity with which the nutritive gases escape from the soil is given by Dr. Madden (Prize Essay 'On the Effects of Drainage,' 'Quarterly Journal of Agriculture,' Dec. 1841). He passed a stream of ammonia for an hour into dry soil; upon weighing it, he found that it had retained only $1\frac{1}{2}$ per cent. of its own weight of gas. 198.6 grains held 3 grains of ammonia. The soil was then wetted and exposed to the atmosphere, and in three hours it was found to have lost 1.8 grains of the gas.

Again, carbonic acid gas was passed over 207.2 grains of soil for an hour, when it was found not to have increased in weight sufficiently to be appreciated; it had not retained $\frac{1}{4}$ per cent. of carbonic acid.

By this it is evident that from a rapidly decomposing substance much of the nutritive gases must escape, if they are evolved at a distance from the plant.*

And if both the rape dust and the seed are spread by the hand, there is a *double waste*—a waste of rape-dust, owing to the extent of surface covered by it, and to the escape of its gases into the air, and the absorption by weeds (which cannot be destroyed until the after-harvest)—and also a waste of seed, to the extent of, at the

* Cuthbert Johnson, who has laboured zealously in advocacy of the drill system, gives "a chemical reason why the manure drill should be adopted to bring, as closely as possible, every plant into immediate contact with the decomposing manure he applies to the soil, and that is, the superior readiness with which, in all cases of decomposition, the disengaged substance enters into new combinations at the very instant of its disengagement, than it does after it has been completely formed. Thus, to give an instance, during the putrefactive fermentation of vegetable substances a quantity of nitrogen is disengaged, and if this takes place under certain favourable circumstances—such as the presence of calcareous matters, potash, and a dry warm temperature at the moment it is formed—the nitrogen combines with oxygen, forms nitric acid, which unites with potash, thus nitrate of potash, saltpetre, is formed; but if the nitrogen is once fairly disengaged, almost every endeavour of the chemist has failed in making it unite with oxygen so as to form the acid of saltpetre."—*Encyclopædia*, p. 538.

However open to doubt this theory of the formation of nitric acid by the decomposition of ammonia and the combination of its nitrogen with the oxygen of the air may be considered, the tendency which elementary substances have to unite with each other when in their *nascent state* may be proved easily. Thus the formation of ammonia by the union of hydrogen and the nitrogen of animal and vegetable decompositions can be proved by different processes. Professor Johnston (*Lectures*, part i. 238) gives several experiments illustrative of *this union*, and of the general principle above named.

least, half a bushel per acre. This every one knows to be the case. And yet there is no produce from it; for a large quantity remains uncovered, and is pilfered by the birds, or perishes—it being well known that seeds, though supplied with heat and moisture, cannot vegetate properly under the influence of light.

From this we conclude that, as there is *much waste* of both seed and manure by the broad-cast plan (owing to the two not being placed in proximity, and at a uniform depth), if we would secure as good a crop as we do by drilling, where the manure and seed *are* placed in close contact, we must apply a much greater quantity of both. Therefore, by using the drill, we have, what we asserted, *a saving in the cost of produce!*

Practical evidence of this *saving* is afforded by the well-known fact, that as good crops are now produced by 4 and 5 cwt. of rape-dust, as were, on its first introduction, obtained by 9 and 10 cwt. sown broad-cast.

The gain in the *quantity of produce*, from an application of rape-dust on the drill system, is thus explained:—

We know that the plant in its infancy feeds upon the matter in the seed. But after it has developed certain fibres, it begins to take up nourishment from the soil, while the green leaf, or shoot, which it has sent upwards, extracts carbonic acid from the air. We know, also, that if its fibres find no food near, they increase in number and length, and spread over a large surface. Thus we find that plants growing in very poor soils have an immense number of fibrous roots, and a poor stunted stem. The reason is, that the plant has exhausted its vigour in its efforts to maintain life; for these numerous roots have been formed at the expense of the matters which ought to have assisted the growth of the stem. By placing, therefore, the manure under the seed, the plant will have no necessity to exhaust itself by such fibrous extension; and, as decomposition will be going on at the time when the plant is rearing its stem and putting out the green leaf, it will be well supplied with liquid and *gaseous food at the most critical period*, and consequently will be able to develop a stouter stem and leaf, and in less time than if the manure was farther distant or more diffused. Indeed, it is a matter beyond question that the sooner the plant escapes from that state of transition, in which it cannot be said whether it derives its food from the seed, the soil, or the atmosphere (the state in which it is commonly said to be “spaining”), the sooner its organs for extracting its food from the air and the soil are developed, the more vigorous will be their growth, and the more efficient their use in the process of vegetation.

From the drill method of applying rape-dust the plant also derives a *better supply of moisture*, so necessary to supply it with

oxygen and hydrogen, to form ammonia with the nitrogen in the manure, and to dissolve the inorganic matters it requires—that moisture without which every farmer is aware no crop can be productive.

This is no delusive advantage. In the first place, it has been proved by Sir Humphry Davy, Professor Schubler, and Cuthbert Johnson, Esq. (and it may be proved by any one), that organic manures, such as rape-dust, possess the power of absorbing from TWICE to TEN TIMES as much atmospheric moisture as the finest soils. It is also equally well proved that the more a soil is pulverized, and the finer the state of division in which its parts are, the greater is its *absorbent power*.* Now, the effect of the decomposition of any matter in a soil is an increased pulverization of the earths in contact with it.† Hence we are justified in con-

* “The power of the soil to absorb water by cohesive attraction depends in a great measure on the state of division of its parts: the more divided they are, the greater is their absorbent power. The different constituent parts of soils likewise appear to act, even by cohesive attraction, with different degrees of energy: thus vegetable substances seem to be more absorbent than animal substances, animal substances more so than compounds of alumina and silica, and compounds of alumina and silica more so than carbonates of lime and magnesia: these differences may, however, depend upon the differences in their state of division, and upon the surface exposed. . . I have compared the absorbent power of many soils with respect to atmospheric moisture, and I have always found it greatest in the most fertile soils.”—(Sir Humphry Davy, *Agr. Chem.*, page 175.) In these trials, “1000 parts of a celebrated soil from Ormeston in East Lothian, which contained more than half its weight of finely-divided matter, of which 11 parts were carbonate of lime and 9 parts vegetable matter, when dried 212°, gained in an hour, by exposure to air (saturated with moisture at a temperature of 62°), 18 parts; 1000 grains of a coarse sand, worth 15s. per acre, gained 11 grains; 1000 grains of the soil from Bagshot Heath gained only 3 grains.”—(Sir H. Davy, *Agr. Chem.*, p. 176.) According to Cuthbert Johnson (*vide* ‘On Fertilizers,’ p. 41), 1000 parts of horse-dung, dried in a temperature of 100°, by exposure three hours to air, saturated with moisture at a temperature of 62°, gained 145; and 1000 parts of rich alluvial soil only 14. In the experiments of Professor Schubler (*vide* ‘Journal of Royal Agr. Soc.,’ vol. i., p. 210)—

1000 grs. of humus (vegetable and animal mould)	absorbed 80 grs. in 12 hours.
1000 grs. of garden soil	35 grs. in do.
1000 grs. of arable soil	16 grs. in do.

† Tull was aware of this, and explained the good effects arising from manure by it. Thus, says he (‘New Husbandry,’ p. 166), “Almost the only use of all manure is the same as of tillage, *viz.* the pulverization it makes by fermentation, as tillage doth by attrition or contusion.”—*The Author.*

cluding that by the absorption of the manure *under*, and of the finely-divided matter *round*, the root, the plant will obtain a more immediate and direct supply of moisture.

Again, this increased supply of moisture is one of the beneficial effects of *hoeing*, which is highly advantageous to the growing crop. In proof of this it is not necessary to quote the opinions of the ancients, or the reasonings of the immortal Tull, the father of the drill system of husbandry, who, astonished by the good results of hoeing, carried his conviction to the extent that nothing more was required to render soils productive than to keep them well pulverized and stirred.* It will be sufficient to say that the action of the hoe increases the attraction for moisture, encourages the circulation of the atmosphere and the nutritive gases, and thus, be the soil what it may, adds to its fertility. In the next place it destroys weeds, which, if permitted to grow, crowd round the root of the plant, and by robbing the soil of its fertilizing matters, and preventing the free access of the air, materially lessen the produce of the corn crop.

The advantages, then, which we claim (upon the grounds we have discussed) for the drill system, are—

1st. *A saving in cost*, from there being no waste of the manure by escape into the atmosphere, or from absorption by weeds; and from the economy of seed.

2nd. *A gain in produce*, from the more ready supply of food to the plant, and the consequent earlier development of its organs of nutrition; from the better supply of moisture; from the destruction of weeds; and from the free access of the atmospheric gases.

If practical illustration of the truth of this reasoning be required, the writer would say that few had better opportunities of seeing the subject tested than himself. Indeed, it was the practice of his father, *for several years*, never to drill a field without leaving one or two portions for a trial of the broad-cast, or other methods of applying the seed and tillage. And the result of those trials was *a full and decided conviction of the superiority of the drill system*. Two cases, also, which occurred during the present year, will serve to illustrate the advantages he claims for this method; and they are not the less valuable because they show what *merely the hoeing part of the system* does for the crop. These cases occurred on the farm of Mr. Joseph Dalby, of Compton, near Wetherby. Thus, a part of a field of wheat, and a part of a field of oats, were left unhoed, and the consequence is, that at this time the produce of the unhoed in both cases is less by full five or six bushels per acre than that of the hoed. The effect was strikingly

* Fresh absorption of carbonic acid is caused wherever the soil is moved, and the advantage of this is incalculable.—G. KIMBERLEY.

evident throughout the summer. Another instance of the superiority of the same system may be seen in a field cultivated by Mr. Gaunt, of Ingmanthorpe, where a portion was left undrilled.

Several other instances of the same sort we have not failed to note.

But there is no necessity for individual cases to be stated. The practice of the first agriculturists of every nation, the plains of Nottinghamshire, the Wolds of Yorkshire and Lincolnshire, and hundreds of acres at *our own doors*, are proofs sufficiently strong of the truth of our reasoning, and of the justice of our conclusion in favour of the drill method of using rape-dust.

Let it not, however, be forgotten that "to every rule there is an exception;" hence, though we contend for the drill method *as a system*, there are cases in which its use would be injudicious. Thus, upon stiff soils, in wet weather, it would not do to use the drill, as the treading of the horses has in such cases an extremely evil effect. The adhesive nature of the soil, in such condition, also prevents the machine from doing its work properly. Upon clover stubble, or light soils, *pressing* is attended with advantage, as it gives to the root of the plant a firm sole, and affords it a better mechanical support against the storms of winter.

Ribbing, too, is a method which answers very well in certain cases. Its trouble and expense, however, do not allow it to be adopted as a system. In cases where it is intended to apply a *large quantity* of rape-dust I would recommend its use; as the tillage and seed are spread over a broader surface than by drilling. There is, therefore, no danger of the fermentation of the manure injuring the germ of the seed. Ribbing and pressing can neither be considered of the broad-cast nor drill system. They may be termed *broad-cast*, inasmuch as the seed is sown from the hand, and of the *drill method*, inasmuch as it is placed in rows or drills—an open seam or furrow being made in both cases, into which the seed and manure fall.*

Dibbling is attended with some advantages—seed and manure are economized; but labour is increased. Upon light soils, when seasons are favourable, and a farmer has plenty of labourers, and but a small breadth of land to sow, it will answer very well. Upon many soils, however, the pressure of the feet is injurious;

* Ribbing upon very light soils gives the wheat plant a firm seed-bed. In this point it has an advantage over the drill. As a system, however, it labours under the disadvantage of being more expensive, more tedious, less economical, and less regular in the application of seed and tillage than the drill. As an *adjunct* to the drill system, to be used in the particular cases mentioned, the method of *ribbing* cannot be too highly appreciated.—*The Author*.

and if we have any extent of land prepared, it is in few, very few cases, that we ought to risk the loss of a seasonable seed-time by adopting such a slow process.*

Let us not forget to observe here, that Dr. Madden does not come to our conclusion as to the best manner of applying rape-dust. From the fact of its quick decomposition, he says that it should *not be drilled with the seed*, as by so doing it will *kill it*. This is true in a limited sense. Rape-dust will kill the seed if a *large quantity be used*. By the drill-system, however, we so *economize* the virtue of the dust, that there is no *occasion to use* a large quantity.†

* To dibbling and all methods of planting or sowing wheat very thin there is one great objection: the wheat is apt to branch too much, the consequence of which is an injury to the root by the winds, &c., owing to the increased leverage of a number of stems. The same principle will account for the fact of wheat being broken down near the root, or '*toad-legged*,' the result of which is an uneven ill-fed sample. Another evil to fear is, that the free supply of the atmospheric gases, moisture, &c., arising from there being so few plants, should stimulate the plant to put forth such a luxuriant foliage and such a number of stems that the root will not be able to convey the matters essential to the perfect nutrition of each branch in the latter stages of its growth (a larger supply of nitrogen, be it remembered, is required to perfect the grain than to maintain the straw), the consequence of which is a large crop of straw and a deficiency of grain. The case alluded to by Professor Liebig of a vineyard being stimulated to the production of so much wood that it became in two or three years almost barren—the fact that if our fruit-trees be permitted to put forth many branches they will bear little fruit—and the case, instanced in a preceding note, of barley being stimulated by rape-dust to too great and quick a production of straw—are familiar illustrations of the evil to be feared from one root having to perform the functions of two or three, and to support, *mechanically* and *chemically*, several stems. Even the turnip, when it has too free access to the soil and the atmosphere, cannot perfect its bulb.—*The Author*.

† "Care must be taken," says Dr. Madden, 'Prize Essays, Highland Society,' June, 1842, "in the application of this manure, because if drilled in with the seed it would inevitably burn it up: when used for barley, the *dust is sown* about *eight days* before the seed." Now I must say that I have seen many thousands of quarters of rape-dust used, but never saw an instance where it was sown a week before the seed. In fact there is no necessity for it, as we may use with perfect security any quantity up to three quarters per acre, and this is *more* than ought to be used to any grain crop, because, as the manure does not last, it is as much as the crop will pay for. Where even three quarters per acre are used once, two quarters, and even one quarter, is used a thousand times, at least in this neighbourhood. I may also add that I never saw a case in which rape-dust, when used in the quantity I have mentioned, though

We come now to consider the application of rape-dust upon turnips.

From what we have already said of its nature and operation, it will be concluded that we do not consider rape-dust so efficacious a tillage for turnips as for corn. The reason is, that the turnip requires a large portion of inorganic matter, such as phosphate of lime, to perfect its growth, which phosphates we are in the habit of supplying by the use of bones, while rape-dust contains but a small proportion of these matters. They, therefore, cannot be supplied by an application of rape-dust. Let us, however, not draw *too general* a conclusion from this fact. It should be remembered that the turnip is a plant subject to many enemies during its infancy, and that it has a large system of leaves, by which it extracts nourishment from the air (hence the bulb is

drilled in ever so close contact with the grain, destroyed or injured the germ of barley, wheat, or oats.

It is, however, *possible* that there may be some who may wish to use a large quantity of rape-dust, though they are well aware that so large a supply of stimulating manure may injure both yield and sample, and that its effects will not be lasting in such cases; it may be well therefore to advise in such cases the sowing of the manure a week before the grain, in order that the potency of the tillage may have partially evaporated: such a plan, in such a case, would be *safe*; will any one say, however, that it would be *economical*?

The principle, therefore, of sowing the manure eight days before the seed, *as a rule*, is quite unnecessary; for I am inclined to think that the farmers are "*few and far between*" who will spend 4*l.* 10*s.* per acre in the purchase of four quarters of rape-dust (the chief peculiarities of which are that it has a "*large excess of soluble organic matter*," "*that it will ferment very rapidly*," and "*will not act throughout the rotation*"), and then sow it a week or a fortnight before the grain, in order that its "*tendency to decomposition*" may cause it to ferment and give off a large proportion of its nutritive gases before the seed comes in contact with it;—few, I say, will do this, when for 2*l.* 5*s.* they can procure as much rape-dust as the crop will pay for (for be it remembered that it acts only for one crop), and by drilling it along with the seed can secure to the young plant an immediate and liberal supply of the nutritive gases with as little waste as possible.

To employ a large quantity of a stimulating matter, quick in its action and transient in its effects, at a great expense, and then to apply it a length of time before it can be of use, in order that a *portion of its fertilizing influence may escape*, and to spread it over a larger surface than is required, *in order that all the influence which it may still possess may not be felt* by the plant, is not a policy suited to the pockets of the farmers of the present day, who find it quite as easy, much cheaper, and equally beneficial to the crop, to employ a less quantity of this matter, and, by placing it under the root, to give the plant the *whole benefit* of it.—*The Author.*

generally found to be in proportion to the size of its broad leaf); it, therefore, should be our object to give it such a manure as will act readily, and cause it quickly to develop those leaves by which it may draw its carbon from the atmosphere, and become, in one sense of the word, independent of the soil, and out of danger from insects, &c.

Now, rape-dust is a manure which, containing a large share of soluble organic matter, acts quickly; it seems, therefore, especially adapted to assist the turnip in the early stages of its growth. As, however, it cannot supply the earthy portion of the plant, it is obvious that it will succeed best upon soils which contain a sufficiency of these earthy phosphates, lime, &c., or when combined with bones, or some other matter containing a supply of these inorganic substances.

The fact of the extensive use of rape-dust in some districts, for turnips, is proof enough that, under the former circumstances, it may be used successfully. The latter position we have fully proved—on several portions, and to the extent of several acres—during the present year. One bushel of rape-dust to three bushels of bones is an excellent mixture. The turnips we have so manured testify this at the present moment. Supplied by the rape-dust with ready nutriment, they grew away quickly; and, when the bones began to decompose, the young plant was ready to make use of their phosphates.*

Much of the success of rape-dust alone for turnips depends on the method of application. Thus, if the seed be placed in immediate contact with the dust, the active fermentation of the latter will destroy the tender germ.† In order to guard against this, it is better to mix the tillage with a little earth or ashes. The tubes should also be affixed to the drill, to convey the seed to the ground, so as to fall immediately after the tillage. By this means a thin layer of earth will protect the seed, and the young plant will have all the benefit of an immediate supply of food without danger of injury.

* In an experiment (the results of which I have lately ascertained) with bones mixed with other manures, this mixture stands first; the yield being 26 tons 15 cwt. per acre.

† The seed of the turnip is so small, and the budding germ so tender, that it should never be placed in contact with any manure which undergoes active fermentation. In such case the whole seed speedily becomes decomposed. This should be particularly guarded against where guano is used. My own experiments last year gave me a proof of this. Mr. Pusey informs me that he has suffered from a similar cause: indeed the complaint has been anything but an uncommon one. The abuse, however, or rather *mal-use*, of an article is no argument against it.—*The Author*.

A drill, with a double row of coulters, was exhibited at the Bristol Meeting of the Royal Agricultural Society, which would be extremely useful in such cases as this.

A few ridges which we drilled in this manner look at the present time very well; some which were drilled in the common manner *with rape-dust and earth* look well. A few drilled with *rape-dust alone, in immediate contact with the seed*, are a failure, a large proportion of the seed being destroyed.

As a manure, also, for *potatoes*, rape-dust is not infrequently used. Like the turnip, the potato extracts a great supply of food from the atmosphere. It contains, also, a larger share of nitrogen than the turnip. It requires, therefore, a ready supply of food, in order that its leaves may come into use as soon as possible; and in this food there should be nitrogenous matter. Rape-dust, acting as we have already shown, and containing so large a proportion of *nitrogen*, appears adapted to supply its wants. But the potatoe also requires a *lasting* manure; nitrogen is necessary in the latter stages of its growth, and rape-dust is not calculated to afford a long supply. For this reason it will be necessary to be liberal in the quantity used: NOT LESS than four quarters per acre should be applied.

With this a mixture of a few bushels of gypsum would have a beneficial effect. It would prevent the too sudden escape of the ammonia (or nitrogen) of the manure, as it will be hereafter shown that it possesses the property of "*fixing*" this gas in combination with one of its own component matters. It is most extensively used along with manure for the potato crop in America, and, according to the best authorities, with success.

Although, then, we should be inclined to say to the farmer, use farm-yard manure for your potato crops, and rape-dust for your corn and turnips, there can be no doubt but that if the latter be applied liberally, in cases where farm-yard manure cannot be had, a remunerative return may be obtained.

A case in point may be instanced upon the farm of Mr. Styan, of Whixley, where a very good crop grown with rape-dust may be seen at the present time.* We are told by a person who has been

* Since the above was written, I find that this crop has not yielded so well as was expected. The reason is very easily given—only 2 qrs. of rape-dust per acre were used, when, as we have shown above, not less than 4 qrs. per acre should be applied for potatoes.

The supply of nitrogen, &c. required to perfect the produce, at the latter stage of the potato's growth, demands a *lasting* manure, as well as an active one; and if rape-dust had been used, it should have been much more liberally applied; 2 qrs. of rape-dust per acre, value 2*l.* 5*s.*, was a poor equivalent to 20 tons of farm-yard manure per acre, value from 7*l.* to 10*l.*—*The Author.*

in the habit of purchasing Mr. S.'s potatoes, that he will give more per acre for those manured with rape-dust than for others grown by Mr. S. with farm-yard manure. There are two considerations of opposite tendency, which should be remembered in using rape-dust for this crop, viz., that though you employ it liberally, it will not leave you a rich fallow; at the same time, it will be a much *cleaner* one than is left after the application of farm-yard manure, which, in the *half-fermented state* in which it is usually applied, fills the soil with the seed of weeds. No method of application for potatoes can be better than that of sowing it upon the ridge, as the plough turns the whole of the tillage into the furrow, and yet so mingles it with the earth, that its fermentation does not injure the young sprouts.

The cost of rape-dust is about 7*l.* per ton, or from 21*s.* to 23*s.* per quarter.

XVI.—Statement of the Various Systems of Cropping in the South of Scotland, on different Kinds of Land. By THOMAS BALMER. Communicated by the Duke of Richmond.

I. Rich Loam.

1. Oats after grass.
2. Turnips: one-half to be eaten on the ground with sheep, and the other half used in feeding cattle, &c.
3. Barley or spring-wheat.
4. Grass: a part to be cut for hay, and the remainder pastured.

This rotation can only be practised with advantage in the neighbourhood of a town, where plenty of rich manure can be procured; and even in that case the land will in time become soft and less productive from not being rested in grass.

II. Dry Turnip Land.

1. Oats after grass.
2. Turnips: one-half to be eaten on the ground with sheep, and the other half to be used in feeding cattle, &c.
3. Barley.
4. Grass: a part to be cut for hay, and the remainder pastured.
5. Grass: all pastured.

This rotation has long been practised, and is considered the best for the above description of land; a farm will certainly not produce a sufficient quantity of manure for the turnip-break; but since the introduction of bone-dust, guano, and other manures, an enterprising and industrious tenant can be at no loss on that account; and if once the land be put into good order, and properly farmed, it is believed it will continue so for any length of time.

III. *Light Sandy Land.*

1. Oats after grass.
2. Turnips: the whole to be eaten on the ground with sheep.
3. Part oats and part barley.
4. Grass: all pastured.
5. Grass: do.
6. Grass: do.

The same remarks apply in this case as to No. II.

IV. *Rich Clay.*

1. Oats after grass.
2. Beans, drilled and hoed.
3. Wheat: properly manured.
4. Turnips: all carted off.
5. Barley.
6. Grass: a part cut for hay.
7. Grass: all pastured.

As this kind of land is too wet to permit the turnips being eaten on the ground with sheep, they must be all carted off, which is very injurious to the soil; but this cannot be avoided until furrow-draining be more extensively practised.

V. *Hard Clay.*

1. Oats after grass.
2. Bare fallow, properly manured.
3. Winter wheat.
4. Grass: a part cut for hay, and the remainder pastured.
5. Grass: all pastured.

Turnips and beans have been attempted on this kind of land, instead of bare fallow, but only succeeded in favourable seasons; and it is believed that in the long run bare fallow will be found to be best. I may, however, remark, that of late years broad clover has failed to a great extent; and it has been found that varying the rotation has had a good effect. Indeed an occasional change is beneficial in all rotations, and on every kind of soil.

In all the different systems, a few potatoes must be planted on the turnip or fallow breaks for the farmer and his servants.

In carting off turnips for cattle, great care should be taken not to go upon the ground in wet weather; and this can easily be avoided by storing a considerable quantity when it is dry; indeed I would recommend that the whole of the Swedish turnips should be taken up and stored about the end of November. I have long been in the practice of doing so to a considerable extent, and have always found them much better in the spring than when allowed to remain all winter in the ground. Various plans have been adopted for storing, but, as far as my experience goes, I have found the best way to be to take off the shaws and roots, taking care not to injure the turnip, and then lay them in long heaps, about 7 or 8 feet wide at the bottom, and as narrow as possible at the top, and afterwards cover them with straw, so as to keep out the frost; they

with tracts of flat and reedy swamps of larger extent, more or less susceptible of a perfect drainage. The conversion of these and similar swampy spots into available land forms one of the most important undertakings to which the improving agriculture of Sweden has given rise.

On leaving the vale of the Gotha, the naked rocks become covered with a thin herbage. In the hollows the soil deepens, and is often of better quality; but where extensive flats occur on the higher ground, they are either covered by woods of pine, or form a more or less inhospitable tract of moor. In some parts of Sweden these flats extend almost continuously over many hundreds of square miles. Covered with a clayey soil to the depth of from 2 to 12 inches, they bear those still and dreary forests of pine through which the traveller, in crossing the country from Christiania to Stockholm, may pass for fifty miles at a stretch without hearing a sound but that caused by his own carriage, or seeing a living thing except in the neighbourhood of the post-houses. On these flats limited crops of corn are here or there raised. A few acres of the wood along the road are burned down, the ashes are strewed over the land, rye is sown and harrowed in, and after one or two crops the spot is again left to nature. Birch-trees first spring up, these are gradually supplanted by the pine, and all traces of cultivation are gradually obliterated. Another of the obvious improvements which Swedish agriculture is now undergoing is the permanent cutting down of the forest *where the soil is deep*, and, by a more skilful and less exhausting system of culture, the conversion of the more accessible spots into regular tillage or grazing farms. But in Sweden there is a limit beyond which this extirpation of the forest cannot be carried, even where the soil is good. The climate is severe, the winters are long, and much fuel is required; here and there peat occurs, but in Sweden generally the chief dependence is upon wood. The fences also are almost universally formed of wood, and hence the price of a farm, or the rent it will bring, is in this country regulated in a very great degree by the quantity of woodland which it contains.*

Among the facts which strike the agricultural stranger on his arrival in one of the rocky districts of Sweden is the readiness with which the young pines take root on the apparently naked sides of the rocks, and gradually clothe it with an almost uninterrupted forest. I had an opportunity of becoming satisfied of this fact during a short visit in the neighbourhood of Gothenburg. My friend had built a house in a pretty situation, with some good low land attached to it. The lower swellings of the granitic rocks

* One-half wood is the proportion which brings the largest price.

he had converted into green hills by covering them with a sprinkling of soil, while the grey sides of the higher and steeper rocks he had concealed by planting, wherever a crevice occurred, young pine-plants obtained from the neighbouring forests. In these crevices the roots fix themselves, and assist the gradual degradation of the rock, from which a soil is formed; and though the first or second generation does not attain a height of more than 15 or 20 feet, yet every new race finds more support from beneath, till even on steep and hanging spots lofty pine-trees are finally seen to flourish.

The comparative condition of agriculture in Denmark and Sweden offers an instructive lesson to the observing traveller. In the former country the capabilities of the land are in general better understood and more fully developed than in the latter. But the causes of this are obvious. In Denmark, as we have seen, light and sandy soils prevail; in Sweden, five-sixths of the land hitherto considered capable of cultivation consist of clay. The former are easily worked, and at little expense; the latter require greater labour, capital, and skill. Again, the climate of Sweden is more severe, which adds a further difficulty to the cultivation of clay-soils; and, lastly, shut out as Sweden has hitherto been by its geographical position and its language from that constant intercourse with other countries which Denmark enjoys, knowledge has spread more slowly from abroad, and the stimulus to improvement has been in proportion less. Soils like those of Denmark prevail over much of Northern Germany, and, connected as Denmark is with the latter country by its German provinces of Holstein and Sleswick, the improvements in German agriculture are more readily diffused among the general Danish population.

In our own country we have occasion to regret the slow diffusion of agricultural information, and the prejudices which among our rural population oppose themselves to the introduction of important improvements in agricultural practice. But if the diffusion of knowledge be slow in our country, where cheap literature of every kind abounds, and where the demands of thirty millions of people, speaking the same language, are sufficient to induce both publishers and authors to bring out books upon almost every subject in regard to which information can be required, how much slower must it be in a country like Sweden, where a population of two or three millions only is to be supplied—where few books will pay even the cost of printing—where no scientific journals exist—where scarcely a magazine of light literature can live beyond a few short months—where the national literature is consequently limited—where there exists no cheap penny reading for the people—and where the instructed must obtain much of

their information through the medium of foreign languages! Conjoin with this the real difficulties which the climate and stubborn soil of Sweden present, and the obstacles arising from surface-water now in course of removal by a general drainage, and we shall have no reason for surprise that a country so near to Denmark should yet be considerably behind it in agricultural improvement.

The government of Sweden has done much during the last thirty years to stimulate the landholders of the country, and at the national cost, to promote the introduction of a better and more lucrative agricultural practice. And so far the growers of food now fully discharge their first great duty to the state. They raise more food than the population can consume, and are obliged therefore to seek a foreign market for their excess of produce.

When the agriculture of a country reaches this point, it may thenceforth follow either of two lines of extension and improvement. It may grow corn, and wool, and other products for exportation, if a foreign market can be found; or it may turn its attention to the cultivation of the luxuries or less necessary articles of consumption, which are usually imported from abroad. In Sweden both directions have been followed. Besides exporting provisions to a considerable extent, the breeding of sheep, for the growth of wool, has been successfully promoted, and attempts are now making to cultivate the beet for the manufacture of sugar, the *madia* (*madia sativa*) for the extraction of oil, and even to raise plantations of mulberry for the rearing of the silkworm. The spirit of improvement is not dormant in a country which, finding itself to possess a power of production beyond the wants of its population in reference to the necessities of life, is found to be attempting, by well-considered and skilfully-conducted experiments, to relieve itself, more or less, completely from its dependence upon other countries at once for sugar and for oil, for wool and for silk. Sweden is still a very thinly peopled country, and the real capabilities of her strong clay soils are yet but little understood; a large increase of her population, therefore, must take place, unless improvement stand still, before she again become dependent upon foreign countries for the first necessities of life.

Among the individuals to whom Sweden is most indebted for the promotion of agricultural improvement during the present century are to be reckoned Charles John, the present King. Ever since he entered the kingdom as Crown-prince he has directed his attention to the development of the agricultural capabilities of his adopted country. Of the instruments he has employed for this purpose, the Royal Academy of Agriculture has been the most important. This academy was established in 1813, with branches more or less active in every province. The presidents

of these branch societies report annually to the academy the kind and extent of the improvements which have been effected, which are in progress, or which they recommend as capable of being brought about by the direct influence or aid of the academy or of the government. At the yearly meeting of the academy the president presents his *general* report, embracing whatever has been doing at home, and exhibiting also a sketch of the most important advances which agriculture has made in foreign countries. By these means the want of a cheap agricultural literature—greater by far in that country than in ours—has been, in some small degree, supplied. Agricultural information and the spirit of improvement have been gradually diffused among at least the most influential classes, and the way has been prepared for the last and greatest step yet taken in that country—one in which the peasantry or small holders of land, the great landholders, and the government have all joined—the *establishment and endowment of agricultural schools*.

In a country like ours, in which great improvement has already been made, and especially at the present time, when all are so anxious to see agriculture advancing still more rapidly, it cannot be uninteresting to mark the several steps which a people of kindred origin with ourselves, and having kindred institutions, situated only in a still more unfavourable climate, have taken, or are now taking, for the purpose of attaining the same great national end to which we look forward. I shall here, therefore, insert a few extracts from the annual report of the president of the academy (Poppius) for the year 1840, the latest report which had been published when I left Stockholm in August last:—

“New canals and roads have of late years facilitated communication, so important to agricultural improvement.* Extensive tracts, by the drainage of surface-water, have been converted into fruitful fields. The division of common lands and the consolidation of farms have been promoted, and money has been lent for the purpose of bringing new lands into cultivation. Measures have been taken for introducing improved breeds of horses, cattle, and sheep. The cultivation of flax has been encouraged by premiums. Schools have been established for imparting instruction in the veterinary art, in the management of forests, and in husbandry; and pains have not been spared for diffusing useful knowledge in regard to agriculture and to domestic economy, both by original native treatises and by translations from the most celebrated foreign writers. The result of all this has been, not only that Sweden, which at the beginning of the century was obliged to import food even in good years, can now export a portion of her produce even in moderately

* “Wherever a new road is constructed, flourishing farms at once spring up, and the carts of the countrymen press on the heels of the road-makers as the work advances.”—*Second Report of the Commissioners for the Extension and Improvement of Public Works in Ireland*.

favourable seasons, but that a sense of the importance of agriculture has been gradually growing in the minds of all classes, so that applications have been made to the government from various provinces for the establishment of additional schools, in which the various branches of knowledge now deemed of importance to the practical farmer may be made more generally accessible. The tilling of the soil is no longer considered as an occupation with which none ought to concern themselves but those who live by their daily toil, but as *a field rather in which the man of science, the landowner, and the practical farmer may labour together*, and from the hidden treasures of which the union of science, experience, and skill may extract an ample reward for the labour of each. A new career is thus opened up for the landowner, in the prosecution of which old opinions and prejudices, and *the fear of loss from the adoption of new methods, will gradually die away*; for it is certain that, *the more agriculture can call to her aid the stores of existing knowledge and experience, the more rapid must be the progress of her future development.*"

He then proceeds to state that, for purposes connected with the draining of marshes, the division of commons, and the consolidation of holdings, the government had expended in 1838 the sum of 174,000 dollars, and, in 1839, 178,000 dollars (about 10,000*l.* sterling). I select a few other particulars upon which the national money was expended in each year :—

	1838.	Dolls.		1839.	Dolls.
For improving the breed of horses	4000		Assessor Plageman's salary	1000	
In aid of the Agricultural Institution at Degeberg	5000		For improving the breed of horses	4000	
For lowering the lake Åsnen, in Southern Sweden	2333		In aid of the Agricultural School at Degeberg	5000	
Special aid of the Degeberg School	1000		Special aid to same school	1000	
To Assessor Plageman for instructing the common people in North and West Bothnia in subsidiary occupations suited to their climate	1000		Salary of the English agriculturist Stephens	1200	
To the English (Scottish) Agriculturist Stephens, for travelling through the country and giving instruction in various departments of practical agriculture	1200		Premium for an improved method of drying unthrashed seed-corn .	5000	
			Premium for a method of drying thrashed grain	3000	
			For experiments in preparing sugar from the white beet	680	
			For lowering the lake Åsnen . . .	2000	

The few items above selected show clearly enough the kind of objects which the Swedish government consider worthy of encouragement, and the enlightened and comprehensive views they entertain in regard to the improvement of the national agriculture. Much larger sums were voted at the last parliament for the establishment of agricultural schools, as I shall mention hereafter more particularly.

The manufacture of iron forms in Sweden an important branch of national industry, and for many years public attention has been drawn to the yearly diminishing or more difficultly attainable supply of the wood by which it is smelted. The injudicious and

indiscriminate use of the axe has left many wide tracts bare which are unfit for arable culture, and which ought therefore to be the sites of the perpetual forests of the country. This has led to the establishment of a school of foresters, the pupils of which, more numerous from year to year, are spreading themselves over the country, and, by directing the future cuttings, and by planting the sites of the ancient woods, have given reason to expect that in a few years the supply will be as ample as ever. Another result of this establishment has been, that numerous trials have been made in acclimatising other trees, and selecting sites favourable for their growth. Lands have been purchased which were found to be propitious to the oak, and millions of trees have already been planted for the use of the navy. The larch also has been found to thrive in the Swedish soil and climate, and has likewise been extensively planted.

In adverting to the proceedings of the provincial branches of the academy, President Poppius states, among other objects to which their attention has been directed, that they have disseminated tracts upon practical agriculture specially adapted to the circumstances and customs of their several provinces—that in some districts small clubs had been formed under the name of *parish committees*, in connexion with the provincial societies, by which committees those points are especially discussed and promoted which bear upon the existing condition of the several parishes, often of great extent—and that many of the provincial societies, some of them singly, others by uniting the strength of two or more provinces, had already taken measures for the establishment of district agricultural schools.

Agricultural Schools.—Since this report was published, the subject of agricultural schools has been more generally taken up in Sweden, and provision has even been made by the diet for promoting, encouraging, and endowing with a yearly revenue every such school—not exceeding one in each province*—which shall hereafter be established. I am not aware of the exact terms of the resolution or grant made for this purpose, but I believe one of its provisions is to the effect that an annual endowment will be given by the state, equal to the interest, at 5 or 6 per cent., of the money subscribed and expended upon the institution by the proprietors and other inhabitants of the province, so long as the institution is maintained. In addition to this, however, they have already given special grants of money to those previously in existence, and of portions of the national domains as sites for the intended schools and school-farms, where these domains happen

* In Sweden there are twenty-four departments (Läro), and about twenty schools are talked of.

to be conveniently situated for the purpose within the several provinces.

The first school was established by Mr. Nonnen at Degeberg, on the south-eastern shores of the Lake Wener, not far from the town of Lidköping, and its success, both in attracting pupils and in imparting obviously useful information, has been such as to give rise to the numerous efforts, already alluded to, for the establishment of similar schools in other parts of the country. It includes two classes of pupils, one consisting of proprietors, sons of proprietors, or such as are likely to farm or to superintend larger tracts of land; another, of intended overseers, or of small proprietors who, though possessing land of their own, must till it, in part at least, with their own hands. To the former class higher branches of learning are taught; to the latter, special instruction is given in those various departments of handicraft which, in a country so thinly peopled, are likely to be useful to the labouring farmer. In the present state of Sweden this distinction of the pupils into classes is of obvious utility, and is copied most probably from the Swiss schools of De Fellenberg; it may be a question with some how far it would be admissible in any schools of the kind which may hereafter be established in our own islands. The total annual expense of a pupil of the higher class in the Degeberg school amounts to 30*l.* or 40*l.*, equal, I should think, to twice the sum in England; I am not aware of the amount of expenses incurred by pupils of the second class. This Degeberg school is indebted for its existence almost solely to the exertions of its director, Mr. Nonnen. It has been aided from time to time by grants from government, free pupils have all along been maintained at it both by government and by the provincial societies, and it is regarded as the model upon which all the others are to be constituted. A school-farm is attached to it, on which new instruments and new modes of culture are tried. Among others the growth of turnips, and other green crops hitherto almost unknown in Sweden, has been successfully attempted. The sheep in Sweden are in winter fed much upon potatoes, but in various provinces trials are now making on the growth both of turnips and of clover.

An agricultural school has already been some years in operation for the united provinces of Christianstad and Malmö in the south of Sweden; one farther north, for the province of Nököping, is under the direction of Mr. Nathärst, the secretary of the Academy of Agriculture; and others are more or less advanced. To the Agricultural Society at Upsala the state has been very liberal. At the last parliament it was decided that the royal domain of Ultuna in the neighbourhood of Upsala should be made over to this society for the establishment of an agricultural

institution. The property was then let on lease at a grain rent of 600 tons, or 6000 dollars (330*l.*) a-year: until the expiry of the lease this rent is to be laid out at interest, to accumulate for the purpose of providing a fund for erecting the necessary buildings; after which the rent of that portion of the estate which is not required for the purposes of the school-farm will form a permanent endowment. The domain is capable of great improvement, and, besides 200 tonner of arable land (240 acres), contains a large tract of rich pasture land on the borders of the Fyriså, the stream that passes Upsala and empties itself into the Macher a few miles below that city. A committee of the larger landed proprietors has been appointed to carry the intentions of the legislature into effect; at the head of whom is Baron Rrömer, the governor of the province, who has interested himself the most in securing the adoption of the measure. Besides the benefit which this institution is likely to effect in introducing better modes of the culture among the numerous small proprietors who abound in this province, its proximity to Upsala will enable it to benefit the whole of Sweden. Upsala has been styled the Oxford of Sweden. To its university the sons of the nobility and of the large proprietors almost exclusively resort; it cannot therefore be unattended with advantage to place under the eyes of such young men the example at once of a well-cultivated farm and the means of instruction as to the mode of equally improving their own possessions. This consideration no doubt had its weight with the legislature in inducing them more largely to endow the Upsala school.

We shall obtain a still more instructive insight both into the state of agriculture and into the working of the spirit of improvement in Sweden, if we glance slightly at some of the special exertions which have been made in the several provinces, as recorded in the President's Report.

In *Christianstad* and *Malmö* three beet-sugar manufactories had been established; and on all the large properties horses and cattle had been introduced for improving the breeds. A royal medal had been given to Isaac Segerstrom for improving and planting drift lands. He prepared the land for this purpose by sowing the land first with *Epilobium angustifolium* (Rose-bay willow-herb), which thrived well and helped to fasten the land. It is added, from experiments made at the Technological Institute, that this plant may be advantageously employed for tanning leather, so that, besides sowing to fix drift lands, it may be used economically in the arts.

In *Holland*, at the expense of the provincial society, Mr. Stephens had visited the province for the purpose of giving advice as to the improvement of the local agriculture, and especially as

to the means of draining certain extensive marshy tracts. Among other results, it is stated that by lowering the lake Ramejöu, at a cost of 14,000 dollars (800*l.*), 4000 tonner of land would be converted into good arable fields. *Durham short-horns* had also been introduced into this province, and prizes had been given to the best ploughmen.

In *Calmar* the alternate husbandry and improved rotations had been introduced with such benefit as to increase the produce on the home-farms of some of the proprietors to two or three times the amount of what could previously be depended upon. The plough was beginning gradually to supersede the *Ärd*,* even among the peasantry. The cultivation of the white beet, for sugar, was extending; and an extensive manufactory of syrup from potatoes has been established. At the request of the Provincial Society, Mr. Stephens had also visited the district, and given much useful advice and agricultural instruction to the farmers.

In the island of *Gothland* improvement is extending by the gradual reclaiming of the wide tracts of moor and marsh which there exist, and by the partial introduction of a rotation of crops. Rape, clover, and root-crops have been cultivated with advantage. Pupils who have returned from Degeberg, after completing their education, have brought with them the knowledge of improved methods of culture, have shown that they are locally applicable, and are gradually producing the conviction of their superiority over the modes usually followed. Experiments have been made in the cultivation of the beet and in the manufacture of sugar, and a *bone-mill* has been established.† Sixteen hundred young mulberry-trees, sent from Stockholm, have been planted near Wisby (the capital of the island), and are thriving well.

In *Kronoberg* the surface of the land is covered with boulders and other stones to a vast extent—the cost of removal amounting commonly to 100 dollars a tunne land (about 1½ English acres). This difficulty in the way of arable culture, the industry of the inhabitants is gradually overcoming,‡ and the use of the plough is

* *Ärd*, or *Ärdret*, is the clumsy and inefficient native plough.

† In a paper upon the use of bone-dust as a manure, contained in the 'Transactions of the Swedish Academy of Agriculture,' complaint is made that bones could not be procured for crushing, in consequence of the high price given for them *for exportation to England*. "And," he adds, "since we cannot give the price for manures which can be well afforded in a country where wheat brings three times the price it does with us, the sale of bones must decrease unless the Government *lay a duty upon the export of the article*."

‡ In ploughing up some of the old grass-fields in Northumberland, between North and South Tyne, I am informed that it has sometimes been necessary to remove as much as 100 tons of stones from a single field, at a cost of 6*l.* to 8*l.* per acre. These stones are chiefly boulders of trap or whinstone, sometimes of large size.

becoming more general. In 1835 the local society engaged Mr. Johnson, I believe a Scottish agriculturist, to remain in the province for five years, for the purpose of giving advice chiefly as to the draining and after-culture of marshy lands. By his assistance it has been ascertained that large tracts may be brought into a productive state; and already, by the draining of lakes chiefly, about 2000 tonners of fertile land have been gained in this province.

In *Ionköping*, public trials of different ploughs and other agricultural implements had been made and their merits explained. Arrangements also had been made by the society for supplying them to the local farmers, of the best construction and at the cheapest rate.

In *East Gothland*, the alternate husbandry was becoming more common, and especially the cultivation of potatoes was extending, as a winter food for stock, and for the manufacture of brandy.

In *Elfsburg*, the society had endeavoured, by the distribution of well-known books, to diffuse information on those subjects to which it is of importance that the attention of the farmer who is striving to improve his condition should be first directed: the raising of green crops was also extending. The society continued to maintain a pupil at Degeberg.

In *Orebro*, attention has been chiefly directed to the introduction of a better management of cattle within the farm-buildings, as one of the methods by which the local agriculture can be most certainly promoted. For this purpose prizes have been offered to the persons who, under certain circumstances, can show the best reared and fed cattle of their own breeding. By these premiums not only is a better farm-management encouraged, but also a larger growth of green food for the cattle.

In *Wermland*, the agriculturist, Mr. Johnson, had for several years been engaged to spend two months yearly in the province, to give advice and instruction as to the draining of marshes and lowering of lakes—and the applications from different proprietors had been so numerous, that they could scarcely all be complied with within the time. Prizes had also been given for the best ploughing. As a proof of the extension of the cultivation of artificial fodder, it is stated that though the society had in one year supplied the farmers of the district with 7600 lbs. of clover and Timothy grass seed, it was far from being sufficient to meet the demand.

It is added that this society had also brought from the province of Kronoberg a skilful wooden-shoe maker; being anxious to supply the demand for such shoes, both on account of their economy and of their preserving the feet of the peasantry from wet, to which in that province they are much exposed.

In *Westmanland*, it is said that the natural meadows, in former times fertile, having become less productive, the method had been adopted of ploughing them out, and after a few crops laying them again down to grass. The gradual wearing out of old pasture lands is here also observed, as it is so extensively in Cheshire. In this province the growth of flax, of whitebeet, and of clover was also extending; marl had been discovered, which was already employed in the preparation of composts; and a considerable extent of meadow land had been laid under irrigation, for which the Hjelmar canal afforded great facilities. Here also attempts were making to introduce the wooden shoe.

In *Gisleborg*, the agriculturist, Mr. Stephens, had been called in, and had advised the inhabitants of the province in regard to available methods by which the local agriculture might be promoted. The manufacture of potash introduced by the society a few years ago continued to extend.

In *Nyköping*, the desire of improvement was restrained among the body of the people by the want of capital. Among the large proprietors the alternate husbandry was extending. Some new land had been brought into cultivation, some of the old worn-out pastures had been ploughed up, to be afterwards laid down again with seeds, and some extent of oak plantation had been formed in the province.

In *Upsala*, the cultivation of clover and the artificial grasses was extending, prizes had been given to the smaller farmers for sheep and cattle reared from native stock, and forty-five head of bulls and cows had been imported from foreign countries by the larger landowners. Operations were also in progress, after a plan of Mr. Stephens, for bringing into an arable state 2000 tons of naturally fertile land. Many English drill and turn-wrest ploughs had lately been introduced, a bone-mill had been erected, and the society had caused that part of 'Professor Lowe's Practical Agriculture' which relates to turnips, potatoes, and other roots, to be translated for distribution in the province. The use of wooden shoes had also been encouraged.*

In *Fahlun*, the alternate husbandry, the use of bone-dust, the preparation of composts, and the sowing of winter corn, are becoming more prevalent.

In the more northern provinces, where corn ripens badly, the chief encouragement has been given to the draining of wet carrs and marshy lands, of which there are a great extent in this part

* I have quoted these exertions for the introduction of wooden shoes to be worn over the leather boot, not only in evidence of the kind of interest taken by the societies in the welfare of the peasantry, but also of the extent to which surface water still rests upon the land in many of the Swedish provinces.

of Sweden. By the multiplication of a hardy race of stock, and by the introduction of subsidiary occupations, the value of these provinces to the state and the comfort of its inhabitants will, it is conceived, be most essentially promoted. Prizes, therefore, have been given for surface-draining and improving such waste lands; the society at Umeå had maintained a pupil at the *Herd-school* in Småland; and the manufacture of potash and saltpetre* had been greatly extended.

In *Jemtland*, one of the western districts of this northern region, a parish committee had been formed in every parish, from which the most beneficial results had followed. The central society, by these means, had been able to collect information in regard to the most remote parts of their wide province, while the members of each parish committee obtained in return advice, instruction, and assistance in reference to their own most pressing wants.

It is in these remote provinces, where long winters reign, and where even the summer season does not bring with it the same full and constant employment which in arable districts the practical farmer meets with, that subsidiary employments, independent of the seasons, become of most importance: hence the anxiety to promote the manufacture of potash and of saltpetre, articles of export for which a ready sale can be found, and in exchange for which other useful commodities may be readily obtained. From the northern provinces of Sweden the finest and most highly prized linen of home manufacture is brought. This manufacture affords a certain amount of occupation for the long winters. The mission of Assessor Plageman, for which, as I have already mentioned, an annual grant has been given by government, has been, chiefly for the purpose of instructing the inhabitants of East and West Bothnia in the extraction of turpentine, and in the preparation of tar, pitch, and other products which their native forests are capable of yielding. This, it will be seen, is another important method of increasing the comfort and wealth of a growing population.†

* The manufacture of saltpetre is an old occupation in Sweden. In certain provinces the occupier of each farm (*hemman*) was bound to deliver so much saltpetre annually to the Government. In some districts this is now commuted into a money-payment, but it is still called the *saltpetre-skaft*—the saltpetre-tax.

† The natives of the northern provinces, both men and women, frequent the more southern districts in quest of employment. Every one who has been in Stockholm has observed the numerous Dalecarlians who, in their native costume, labour in the streets of that city. They are generally preferred, where assiduous labour is wanted, to the natives of the district. In the neighbourhood of Upsala, I was informed, that of the females employed in agricultural labour, the native received 20, and the Dalecarlian woman 27 skillings a-day (6d. to 8d. sterling). The Dalecarlians live upon 10, and send the rest home.

It is far more usual in continental countries than among us for the larger farmers to follow some branch of agricultural manufacture, if I may so call it, by which part of the raw produce of the land is converted into an article of more ready sale, and perhaps of larger profit. A distillery is the most common appendage to the farm. By the manufacture of brandy large quantities of potatoes are worked up into an easily transported article, while the refuse helps to feed the stock. More rarely a brewery is attached; but they require more skill, the produce is more bulky, and the raw material itself, from which the liquor is prepared, is of as easy transport, and generally meets as ready a sale. The manufacture of sugar from beet is pronounced in France to be the most advantageous and one of the most *natural* adjuncts to the ordinary routine of the farmer; and in every part of Sweden where the beet flourishes efforts are now making to introduce it as a subsidiary occupation on the larger properties. A method has been discovered of preserving the beet during the long winter without alteration of the sugar in its sap, and thus a sufficient stock being laid in, a new means of employment for the people during the snowy months is likely to be in certain districts obtained.

The above sketch of the march of improvement in Sweden, and of the line it is taking in the several provinces, will not, I trust, have proved fatiguing to my reader. To myself the more detailed account contained in the President's report has proved very interesting. Each statement of what has been done tells also of much that yet remains to be done. The different steps adopted in each province show how much circumstances must modify the course of the most zealous and enlightened improvers, and how impossible it is to lay down any general plan by which the greatest amount of good can in *every locality* be effected at the least cost of money and of time. Here better instruments should be first introduced—there a better rotation; here agricultural tracts ought to be first disseminated—there a skilful agriculturist, by personal counsel and persuasion, will effect the most; here exhausted pasture should be ploughed up—there old tillage land laid down to grass; here one piece of land is robbed to enrich another—there manures are altogether wasted; here better breeds of cattle are the first thing required—there an efficient system of drainage would most largely increase the produce.

It cannot be doubted, however, that the mode adopted in Sweden of publishing officially and diffusing through all the provinces a knowledge of what is doing in each, must be productive of much good. The improver in each district will benefit by the exertions made in other parts of the country. He will say, can this not be done here—will beet, or clover, or turnips, not grow upon some of our land—would not a visit from the agricul-

tourist be of great use here also—would our small farmers not be benefited by some little tracts upon improved modes of husbandry, of rearing cattle, or of domestic economy?

I may be permitted perhaps to ask, if some of our large county societies might not imitate with advantage some of the proceedings of those in Sweden. It is the nature of all human institutions to react upon one another. Sweden looks up to British agriculture as the model for imitation. Her agricultural societies look with admiration to the proceedings of ours. They have selected what is good in our procedure, so far as it was adapted to their different circumstances; and, by the suggestions of their own judgment, they have added some things which nearly all our societies may find it beneficial to imitate.

I have no doubt that, had we any general statement of all that is now doing by all the agricultural societies in our own islands, we should find that there was not only no practical idea which, as a nation, we have to borrow from other countries, none that in one corner of the empire or another is not known, and more or less extensively acted upon—but we have no such record. The leaders of most societies are only partially aware of what is elsewhere going on, and thus the idea not occurring to them, the opportunity for promoting this or that good purpose is permitted to pass away. It might be a laborious task for the presidents of our national societies to give an annual report of what has been recently effected in our several counties; but it would be highly useful, not only as a record of past exertions, but as an index at once and a stimulus to new improvements.

I shall make only one or two further observations in regard to Swedish agriculture. Five-sixths of the surface are said to consist of clay. This clay is often of a pale colour, runs together, and in dry weather becomes very hard. It is at all times difficult and expensive to work, but it is pronounced by good English judges to be well adapted to the growth of wheat. At present the only drainage practised is by open surface drains; even with this good crops are frequently obtained. The idea prevails among the leading improvers that covered drains (our furrow-drain system) are not adapted to their climate—that they would be destroyed, or rendered more or less inefficient, by the severe frosts. Experience, I think, will show that this apprehension is unfounded—and that the construction of the drains may be so modified as to secure their permanence. When, therefore, Swedish agriculture has gone through the first stage, along which it is now travelling—when the surface water is carried off from the low lands and marshes, there will remain for it still a greater and more expensive undertaking—the furrow-draining of the stiff clay lands. This is

the task which English agriculture has now undertaken, by the accomplishment of which she has almost certain hope of doubling the produce of her yet undrained clay soils, but in which, with all her great resources of capital and labour, she can make only a slow advance.

But another important step must in Sweden precede the outlay of such sums as a general drainage of this kind would require. Notwithstanding the exertions now making, and the improvements actually in progress, it is said that nearly one-half of the arable land of the kingdom is still year by year in naked fallow. A crop of corn, and a naked fallow alternately, is the old system of Swedish cultivation. Improved rotations have assumed first the form of naked fallow, rye, barley, or wheat; and after this, in some cases, three years of grass. The extension of green cropping, by rescuing a large portion of this naked fallow from unnecessary idleness, will alone add largely to the national produce. A better drainage will more naturally follow or flow from the accumulated capital to which this more productive rotation may be expected to give rise.

Durham, 1st Feb., 1843.

XVIII.—*Account of some Experiments with Guano, and other Manures, on Turnips.* By JOHN GREY.

By Mr. Jobling, of Newton Hall, Northumberland.

	Tons.	Cwts.
1. An acre of globe turnips, with 100 lbs. of guano upon 10 single-horse cart-loads of farm-yard manure, produced, when weighed in December	22	1
2. An acre of the same turnips, and on the same land, with 20 single-horse cart-loads of the same manure, produced	14	2
3. An acre of Swedish turnips, with 200 lbs. of guano mixed with 4 bushels of sifted house-ashes, produced	14	3½
4. An acre, adjoining the above, of the same turnips, with 25 single-horse cart-loads of farm-yard manure, produced	10	16

By the Rev. Archdeacon Scott, at Whitfield, Northumberland.

	Tons.	Cwts.
5. Four rows of Swedish turnips, with guano alone, at the rate of 2 cwt. per acre, produced 17 cwt., or at the rate per acre of rather more than	11	0
6. Four adjoining rows, in every respect equal to the above, manured with the ordinary quantity of farm-yard dung, produced 29 cwt. 84 stone, or at the rate per acre of	19	0

N.B.—A bushel of the swedes grown on guano weighed, when cleaned of top and root, 47 lbs.; and a bushel of those grown on dung 43 lbs.*

The archdeacon remarks very justly, "I am strongly of opinion that the guano ought to be mixed with a large quantity of ashes, and spread upon the land before raising the rows upon which the seed is to be sown." The correctness of this opinion is proved by a circumstance communicated to me by Mr. Ridley, of Park-End, in this county, last year. He deposited guano in the hollow of the rows, covered it up by the plough, and sowed the seed in the usual way with a drill, but none of it vegetated; but after ploughing the land across the rows, so as to mix the guano with the soil, ridging it, and sowing again, he had a very good crop.

By Mr. Grey, of Dilston, Northumberland.

Manure, per Acre.	Cost.			Crop.	Produce.	
	£.	s.	d.		Tons.	Stones.
7. 2 cwt. guano, 34s.; 4 bushels wood-ashes, 6s.	2	0	0	{ Border imperial } { turnips . . }	14	21
8. 20 single-horse loads of fold-yard manure, at 2s. 6d.	2	10	0	Ditto	19	39
9. 2 cwt. guano, 34s.; 4 bushels wood-ashes, 6s.	2	0	0	Swedish turnips	17	109

By Mr. Darling, of Helton House, Northumberland.

Manure, per Acre.	Cost.			Crop.	Produce.	
	£.	s.	d.		Tons.	Stones.
10. 2 quarters bones	2	2	0	White globe	23	58
11. Horse and cattle droppings, collected in the fields at 1s. per cart-load, 8 loads	0	8	0	Ditto	19	0
12. Ashes of couch grass, 5 cart-loads					17	0
13. 2 cwt. guano, at 17s.	1	14	0	Ditto	19	0
14. Artificial guano from Glasgow, with ashes†	1	10	0	Ditto	9	10
15. The same, on land which had a dressing of fresh soil in the previous winter	1	10	0	Ditto	19	23
16. 18 single-horse carts of farm-yard manure, at 2s. 6d.	2	5	0	Ditto	26	0
17. 20 ditto ditto ditto	2	10	0	Swedes	22	0

* This difference in weight probably arose from the difference in size of the turnips, as small turnips pack closer and weigh heavier than large ones, by measure, though less by the acre. It may be observed, too, that in all these experiments with farm manure, there is the absence of any test of its quality, and the precise state as to the fermentation it had undergone when applied to the land, which is sufficient to account for the varying results. I proved by experiment, many years ago, that 1 ton of manure taken from a yard in which cattle were fed on full turnips, with a portion of oil-cake and bean-meal, was worth 3 tons of that (though apparently in equally good state) which was made in a yard where young cattle were kept on straw during the night, with a run out in the fields, getting a few turnip-tops in the day. It is therefore deserving of the farmer's attention, when carting his manure, to form heaps in the field for his turnip land, to be careful to mix the different kinds intimately together; or if that should not be convenient, to give to that of poor quality an additional dressing of guano or bone-dust.—J. GREY.

† But for the quantity of ashes with No. 14, I am persuaded there would have been no crop at all.—G. DARLING.

On Corn.—By Mr. Jobling, of Newton Hall.

18. An acre of land, cropped with oats, was top-dressed with 200 lbs. of guano, and 2 bushels of house-ashes, sifted, after the oats were in braid, at a cost of 30s. per acre. The produce in oats was . . . 63 bushels.
 Weight of straw 66 stones.
 The produce of 2 half-acres, on each side, which had no manure, was, in oats 55½ bushels.
 Weight of straw 57 stones.
 Leaving a difference of 7½ bushels of oats, and 9 stones of straw, in favour of the guano and ashes, which will not repay the cost.
- An acre of land, inferior to the former in quality, was treated in the same way, and produced . . . 30 bushels.
 While an adjoining acre, without manure, produced 24 „
19. An acre of land, growing wheat, was top-dressed in the same way, without producing any sensible superiority over the adjoining crop.
20. An acre of land had the same mixture applied to it before sowing the wheat in autumn, the crop upon which was considerably lighter than that on each side, which had received 15 single-horse cart-loads of common manure per acre.

From results so varying and contradictory, although no correct judgment can be formed as to the general applicability of guano to different kinds of soils and crops, some practical use may nevertheless be derived. One thing I think may be taken as proved—that it is not advisable to use guano alone, or even with a very small mixture of ashes, or other such like substances. I was much disappointed in the result of experiments 7 and 8; for during all the early part of the season, the turnips grown on guano took the lead of the others, having a much larger and darker-coloured leaf, and covering the ground much better; and I am persuaded that if both plots had been weighed in the end of September, instead of December, the balance would have been in their favour; but early in October they ceased to improve, the leaf fell, and they looked faded and unhealthy; whereas those on the fold-yard manure began at that time to recover, in some measure, from the effects of the extreme heat and drought of the summer. The showers which fell in October, that produced no effect on those sown upon guano, greatly recruited those sown on fold-yard manure. They assumed a fresh appearance: the yellow and mildewed leaves gave place to others of new growth, and the roots swelled out to a size which had previously seemed hopeless. The crop became rather good than otherwise, for so unfavourable a season as it was here; and the comparative weights show the final superiority of farm-yard manure over guano, upon a turnip loam with a sandstone basis. In watching the progress of these two

plots—the rapid growth and early vigour of the one, with its complete cessation at a certain period, and the continued increase and actual revival of the other at a late stage—it seems reasonable to conjecture that guano gives off its ammonia too rapidly to supply and stimulate the plant for a sufficient length of time to bring it to maturity, and that the reverse is the case with farm-yard manure; and, therefore, that guano is best applied as a stimulant in the first stages of growth, but that it ought to be accompanied with some other manure whose effects are more lasting. This conclusion is borne out by the result of Mr. Jobling's judicious experiments (Nos. 1 and 2), where it is seen that the turnips from an acre which had 10 loads of dung, and 100 lbs. of guano, weighed one-third more than those from an adjoining acre with 20 loads of dung. The land on which this experiment was tried, although by draining and subsoil-ploughing it has been made to grow good turnips, is rather of a stronger quality than what is commonly designated as turnip land, and on which the growth of the turnip plant is generally slow until it gets hold of the manure; but in this case I doubt not that it was rapid from the first—the guano supplying its early nourishment, and being succeeded by the more lasting effects of the farm-yard manure, it was carried forward without a check throughout, and maintained a decided superiority to the end. Its failure, too, when applied to wheat (Nos. 19 and 20), a crop which requires support for so many months, is another proof of its want of durability. We may learn, too, from these experiments, inconclusive and unsatisfactory as they undoubtedly are, that anything compounded and sold under the name of “artificial guano” should be adopted with great caution (see No. 14); and that none of the newly-introduced manures, however beneficial they may prove in peculiar soils and situations, are so generally certain and lasting in their effects as the common manure of the farm; and that the farmer, therefore, can never bestow too much pains on making and preserving all the manure which it is possible to produce on his own premises.

It may well excite surprise to see, in some districts of this country, a great quantity of straw left upon the land by a slovenly mode of harvesting, where it is of no use, which, if carried home, would greatly increase the quantity of dung in the fold-yards, while at the same time the farmers are buying bones or other manures to supply their deficiency.

Dilston, February 13, 1843.

XIX.—*Lecture on the Applications of Physiology to the Rearing and Feeding of Cattle.* No. 1. By LYON PLAYFAIR, Ph. D., F.G.S., Honorary Member of the Royal Agricultural Society, &c. Delivered to the Society, December, 1842.

I. *On the General Principles of Nutrition and on the Food of Cattle.*

IN compliance with the request of the Council of our Society, I have ventured to appear before you for the purpose of examining, in its scientific relations, one of the most important branches of Agricultural science. Recent discoveries have thrown much light upon the vital and chemical processes engaged in the nutrition of animals: it therefore became an important question, whether these discoveries tended to elucidate the practice of feeding cattle? It would be presumptuous in any scientific man, however exalted his rank in science, to endeavour to instruct an assemblage such as this, or to recommend alterations in the practice of an art which he has learned in the closet and not in the field. But it may be permitted, even to the most humble cultivator of science, to examine the practice which you yourselves have perfected, and to point out the laws of nature upon which that practice depends. This is in accordance with the principles which your Society has adopted, and by which it has been induced to enrol amongst its members men professing the cultivation of various branches of philosophy.

I therefore thought it my duty, as a willing soldier of the Society, to appear before you in obedience to the commands of our Council, and to endeavour, however humbly, to examine the subject which it assigned.

But before we can examine the applications of physiological science to the feeding of cattle, we must in the first place be possessed of a clear conception of the leading theories connected with animal nutrition. The principal part of this lecture will be devoted to this subject; and in our next lecture we shall consider those theories in their more immediate applications to practice.

Vegetables derive their principal nutriment from the air. Many mineralogists class air as a gaseous mineral. Hence the vegetable kingdom may be said to derive its nutriment from sources entirely *inorganic*. Animals, on the other hand, subsist only upon *organic* matter, i. e., upon substances which have at one-time formed part of a living organised being.

The primary nutriment of all animals consists of vegetable matter. The carnivora, indeed, live wholly upon flesh; but the animals which furnished this flesh derived their nourishment from

plants. Hence these must contain substances adapted for the sustenance of the animal frame.

All vegetable food has been found to contain a peculiar substance, which, though it differs in appearance and in form, according to the source from whence it is obtained, is in reality the same body. It has received the name of gluten or albumen, and is precisely identical, in chemical composition, with the albumen obtained from the white of an egg. This substance is invariably present in all nutritious food. Chemists were surprised to discover that this body never varies in composition; that it is exactly the same in corn, beans, or from whatever plant it is extracted. But their surprise was much increased when they remarked that it is quite identical with the flesh and blood of animals. It consists, like the latter, of carbon, hydrogen, nitrogen, and oxygen, and in the very same proportion in 100 parts. By identity in composition is not meant a mere similarity, but an absolute identity; so much so, that if you were to place in a chemist's hand some gluten obtained from wheat flour, some dry albumen procured from the white of an egg, a fragment of the flesh of an ox or of a man, or some of their dried blood, and request him to examine their difference, he would tell you, strange as it may appear, that they are precisely the same, and that with all the refinements of his science he was unable to detect any essential difference between them. There is much difference, indeed, in external appearance and in structure, but in their ultimate composition there is none. To render this more obvious I subjoin the composition of these various substances, as obtained by different chemists, who executed their analyses without any knowledge of the results obtained by the others:—

	Gluten from Flour. Boussingault.	Casein from Pease. Scherer.	Albumen from Eggs. Jones.	Ox Blood. Playfair.	Ox Flesh. Playfair.
Carbon . .	54.2	54.138	55.000	54.35	54.12
Hydrogen . .	7.5	7.156	7.073	7.50	7.89
Nitrogen . .	13.9	15.672	15.920	15.76	15.67
Oxygen . .	24.4	23.034	22.007	22.39	22.32
	<hr/> 100.0	<hr/> 100.0	<hr/> 100.00	<hr/> 100.00	<hr/> 100.00

These analyses do not differ from each other more than the analyses of the same substance usually do. Thus we are led to the startling conclusion, that plants contain within them the flesh of animals ready formed, and that the only duty of animals subsisting upon them is to give this flesh a place and form in their organism. When an animal subsists upon flesh, we find no difficulty in explaining its nutrition; for the flesh being of the same composition as its own body, the animal, in a chemical point of view, may be said to be eating itself; nor, with a knowledge

of this identity of vegetable albumen with flesh, is there any difficulty in comprehending the nutrition of vegetable feeders.

Plants, then, in reality form the *flesh* of animals ; and the latter, merely appropriate it a place in their organism.

A little consideration will show that this is a very wise arrangement of nature. The vitality of plants is not required to execute the commands of volition, and therefore its whole powers are employed in creating new compounds ; but in animals the vital principle has many duties to perform, assigned to it by the will. Its powers are therefore husbanded for this end, and not expended in compelling the chemical forces to yield their usual affinities, for the production of particular constituents of the body, out of substances wholly dissimilar in composition. All, then, that the vitality in the animal economy has to perform connected with nutrition, is to assign a place and form to the food, which is already of the proper composition.

It is to Liebig that we owe the discovery of this important fact ; for the analyses now placed before you (with the exception of that by Boussingault) were executed at his request, in order to establish the truth of his views.

The food of herbivorous animals contains other compounds, such as starch, sugar, and gum. From these the element nitrogen is absent, and hence they cannot of themselves form flesh. Indeed, in one sense, they cannot be considered as nutritious, for it is found that animals die when fed upon such food alone ; yet constituents of plants destitute of nitrogen occur in the food of all vegetable feeders. For what purpose, then, are they designed ?

The average temperature of the bodies of our cattle is about 100 degrees, or more than 40 degrees higher than the ordinary temperature of this climate. Hence there must be some provision in the animal body to sustain the heat, which is absolutely necessary for the performance of the organic functions. The air, being so much colder than the body, must constantly withdraw from it heat, and tend to lower its temperature. Whence, then, comes the fuel for the production of the heat ?

The fuel consists of those ingredients of food from which nitrogen is absent ; they all contain carbon and the elements of water. We know that oxygen is continually exhaled in the air we breathe, and that it is never again expired as such. Expired air consists of carbonic acid, a gas composed of carbon and oxygen. In the body therefore, the oxygen has united with carbon ; *or it has produced the very gas which is obtained by burning a piece of charcoal in the open air.* Now the heat generated by the combustion of the carbon in the body must be exactly equivalent to that produced by burning the same amount in the atmosphere.

Experiments have taught us that the average quantity of carbon in the food of an adult man amounts to 14 ounces daily. By the combustion of this quantity, 197,477° of heat are produced (Liebig); and this is amply sufficient to account for the heat of the human body. The experiments of Boussingault show, that a cow breathes out about 70 ounces of carbon daily, and from this we calculate that 987,385° of heat must be produced in the body of a cow in the space of twenty-four hours.* These calculations will at once prove that there is little difficulty in accounting for the heat of the animal body.

But as the heat of the animal body is the same in all regions, it is obvious that the quantity of fuel (food) necessary to sustain the constant temperature of the body must vary according to the nature of the climate. Thus less food is required for this purpose in India, where the temperature of the external air equals that of the body, than in the polar regions, in which it is very many degrees lower. But a beneficent Providence has arranged the produce of different countries so as to meet the exigencies of the climate. The fruits, upon which the inhabitants of warm countries love to feed, contain only 12 per cent. of carbon, while the train-oil enjoyed by the inhabitants of arctic regions contains above 70 per cent. of the same element.

"Were we," says Liebig, "to go naked like certain savage tribes, or if in hunting and fishing we were exposed to the same degree of cold as the Samoyedes, we should be able with ease to consume 10 lbs. of flesh, and perhaps a dozen of tallow candles into the bargain, as warmly clad travellers have related with astonishment of these people. We should then also be able to take the same quantity of brandy or train-oil without bad effects, because the carbon and hydrogen of these substances would only suffice to keep up the equilibrium between the temperature of the external air and that of our bodies."†

We often wonder how the Greenlander or Russian can relish train-oil: we know perfectly that our own organs of digestion would refuse to receive it; but the cases are very different. In cold countries the air is much condensed, for you are well aware that air expands by heat and contracts by cold. Hence the inhabitant of a cold region receives much more oxygen at each respiration than the inhabitant of a hot country, in which the air is expanded by heat. In a cold country, therefore, more carbon is necessary to combine with the excess of oxygen than in the hot country. As oxygen never escapes from the system after having entered it, except in union either with carbon or with hydrogen,

* This implies the union of 11 lbs. 10½ oz. of oxygen with the carbon.

† Chemistry applied to Physiology and Pathology. Edited by Dr. Gregory.

anything which tends to increase the amount of oxygen inspired will occasion a greater consumption of food. Thus exercise increases the number of our respirations and consequent supply of oxygen to the system, and the result is, that, after exercise, we consume more food than we should have done had we not received it.

The only use of clothes, in the abstract, is to economise food. They assist in retaining the heat of the body, and render less food or fuel necessary for this purpose.

In herbivorous animals the fuel used in the production of heat consists of sugar, starch, gum, and other ingredients of food, which do not contain nitrogen.

In carnivorous animals, or those which live entirely upon flesh, the heat of their bodies is supported by the combustion of their own tissues. Hence it is that we see the hyena, pent up in the cage of a menagerie, move continually from one side of the den to the other. These movements do not arise from an impatience of confinement, but from the necessity of sustaining the temperature of its body by the combustion of its tissues. Its continued motions accelerate the waste of its body, and introduce more oxygen into its system by the increased rapidity of its respirations.

From this rapid sketch of the functions performed by the various ingredients of food, you will be enabled to understand the meaning of the following table, which is extracted from Professor Liebig's work on Animal Chemistry:—

Elements of Nutrition.		Elements of Respiration.	
Vegetable fibrine		Fat	Pectine
„ albumen		Starch	Bassorine*
„ casein		Gum	Wine
Animal flesh		Cane sugar	Beer
„ blood		Grape sugar	Spirits
		Sugar of Milk	

The elements of nutrition contain nitrogen, and are of the same composition as flesh, while the elements of respiration are destitute of nitrogen, and unfitted for the *nutrition* of the animal frame.

II.—In the preceding part of the lecture we have given a rapid sketch of some of Liebig's discoveries in Animal Nutrition. We cannot follow him, on an occasion like this, in his elaborate reasonings, to prove the accuracy of his views; but at the same time it is necessary that you should be possessed with a perfect confidence of their truth, otherwise you will be unwilling to admit the explanations which they furnish of your own practice.

* The chemical substances called *pectine* and *bassorine* are the pure principles of gum and mucilage.

I shall, therefore, consider the subject more in detail, and base my arguments, not on theoretical deductions, but upon facts occurring in your every-day experience.

If I succeed in convincing you of the truth of these theories, then you are in a position to examine your own practice. If they do nothing more than explain the principles of your practice, this will still be of much benefit; for these principles being once known, you will be enabled to regulate it in a way best adapted for the purposes intended. Blindfolded Ignorance gropes with hesitating steps through "pastures new;" but Knowledge steps boldly forth, carrying along with her the lamp of Science to light her on her way. The duty of scientific men is only to show how practical applications may be made; it is the duty of practical men to discover and make those applications.

We have already explained that the heat of the animal body is supported by a combustion, or union with oxygen, of those constituents of food from which nitrogen is absent. But we have not yet considered the nature of the forces which exist in the body and produce its increase of mass, as well as occasion that waste for the restoration of which food is taken. It cannot be to sustain the heat of the body alone that a supply of food is requisite, for there exist in it other substances unfitted for the support of respiration, except under peculiar circumstances. What, then, are the ruling forces in the body by which its substance is increased or destroyed?

In every part of the animal organism resides the peculiar principle named Vitality. It is the cause of life, and is quite distinct from the divine essence—the mind. Vitality is a power subject to laws such as govern other forces in the material world. For example, we can act upon the vitality of the finger by a blister or a hot iron, and can thus increase or diminish its intensity.

The purpose for which this mysterious principle is implanted in the organism of an animal is to protect the matter of which its parts are composed from the action of the chemical forces. Matter is placed under the dominion of chemical affinity, whose constant aim is to produce new changes. It has a great desire to effect the total destruction of the Organic kingdom of nature, by making it pass into the Inorganic kingdom. Vitality is, therefore, implanted in the animal organism to stand in antagonism to this power.

The object of vitality is to sustain and increase the mass of the body in which it resides; the object of the chemical forces is to destroy and waste that body. Vitality resides in every part of the fortress which it has to defend: the chemical forces are encamped in the atmosphere which everywhere surrounds it. In fact, the chemical power is the gas oxygen, one of the principal constitu-

ents of common air; and its affinity for the elements of organic matter is so great, that it constantly endeavours to destroy it.

The whole life of an animal consists in a conflict of these rival powers—in the endeavour of vitality to sustain and increase—in that of chemical affinity to waste and destroy. In *health*, vitality possesses the ascendancy, and modifies the destructive efforts of the chemical powers. *Disease*, on the other hand, is a temporary conquest of the chemical over the vital forces; while *death* is the victory of the former, and annihilation of the latter.

When the chemical power oxygen succeeds in effecting a waste of the body, it converts it into the elements from whence it sprung—into carbonic acid, water, and ammonia. There are indeed intermediate compounds formed, but these are the final products of the decay of the body or of its parts; and they are the very substances upon which plants live: so that decay and death thus become the source of life. It is known that the vital forces decrease when the body is exposed to a certain degree of cold; and when this is sufficiently intense, that they are either suspended or are altogether annihilated. But the chemical force oxygen is condensed or increased in its power by such agencies, and it therefore now reigns triumphant. Vitality (the cause of increase and of sustenance) being removed, chemical affinity (the cause of waste) acts upon those tissues which have been freed from the dominion of vitality, and effects their destruction. Hence it is that cattle do not fatten so well in cold weather as in hot. The chemical powers being now in the ascendant prevent the increase of mass. We know, also, that the intervention of cold weather in summer either wholly arrests, or greatly retards, the fattening of our cattle. But as the decrease of vitality has been occasioned by a diminution of the temperature of the body, it is obvious that by an elevation of the temperature vitality would be again enabled to resume its proper functions. It has been shown that the food of various countries is more or less combustible, according to the temperature of the climate; and proofs were adduced that the amount of the food consumed varied also according to the temperature. The animal body is a furnace which must be kept up to a certain heat in all climates.* This furnace must, therefore, be supplied with more or less fuel according to the temperature of the external air. If then in winter we wish to retain the vital functions of our cattle in a proper degree of activity, we must keep up the heat of their bodies. This we may do in two ways. We may either add more fuel (food) to the furnace, or we may protect

* This is a homely and trite comparison, but a very perfect one. The body is the furnace—the food is the fuel—the excrements are the ashes—and the gases expired from the mouth are of the same composition as those which fly up the chimney of the furnace.

their bodies from the cold. Warmth is an equivalent for food, which may thus be economised. But I wish to give you facts, not assertions; and as a proof of the view I have now given you, I will cite the following experiment which was made by the Earl of Ducie at Whitfield farm.

One hundred sheep were folded by tens in pens, each of which was 22 feet in length by 10 feet in breadth, and possessed a covered shed attached to it of 12 feet in length by 10 feet in breadth. They were kept in these from the 10th of October to the 10th of March. Each sheep consumed on an average 20 lbs. of swedes daily. Another hundred were folded in pens of a similar size, but without sheds attached. They were kept during the same time, and their daily consumption of swedes amounted to 25 lbs. each. Here the circumstances were precisely similar with respect to exercise, the only difference being that the first hundred sheep had sheds into which they might retire, and thus be partially protected from the cold.

This partial protection was equivalent to a certain amount of food, and consequently we find that the sheep enjoying this protection consumed one-fifth less food than those sheep which were left entirely exposed to the cold. In the last case the consumption of the additional food arose wholly from the necessity of adding more fuel (food) to the furnace of the body, in order to keep up its normal temperature. This was proved from the circumstance, that those sheep which enjoyed the protection had increased 3 lbs. each more than those left unprotected, although the latter had consumed one-fifth more food.

I do not, at this stage of the inquiry, refer to Mr. Childers's beautiful experiments on feeding sheep in sheds, as these involve another theory which has not yet been discussed.

I wish particularly to impress upon you that warmth is an *equivalent* for food, and that, therefore, food may be economised by protecting cattle from the cold. The honey stored up by bees is for the purpose of serving as fuel to keep up the heat of their bodies during the winter. Now it has been found that when two hives of bees are placed in one hive during winter, that they actually consume less honey than each hive would have done separately.* You will easily perceive the explanation of this circumstance from the facts which I have already stated. Their close contiguity prevents a rapid escape of the heat of their bodies, and consequently less fuel (honey) is required to keep up the temperature. This case forms a very distinct proof that warmth is an *equivalent* for food.

But I need only refer you to the results of your own experience;

* Transactions of the Oxford Apiarian Society.

for every breeder of cattle must be aware, in the wintering of young stock, that they thrive better, with less consumption of food, when kept well sheltered from cold and wet.

The assimilative power of the graminivora is enormous, and the quantity of food which they consume is proportional. In summer, when the temperature of the air approaches more nearly to that of the body, the heat generated by the combustion of this food is more than is sufficient to retain the normal temperature of the system. Hence it is that we find oxen so much inconvenienced by hot weather, and that we observe them standing in streams of running water, or exposing themselves, with evident satisfaction, to a shower of rain. The cold water serves to carry off the redundant heat and, consequently, matter, from the body; for heat is produced by the combustion of matter. This practice therefore, although agreeable to the cattle, can scarcely be a profitable one for the grazier.

The air in summer being so much expanded by heat, much less air is taken into the system in an equal number of respirations than in winter—consequently less oxygen is consumed. But oxygen is the principal acting chemical force; it is, therefore, the cause of waste. The case of cattle now feeding is the very reverse of what it is in winter. In cold weather, the vital force (cause of supply) is reduced in energy, whilst that of the chemical force is augmented; but in summer, the vital functions are elevated and the chemical powers depressed. Vitality, having now a diminished force in antagonism to its action, exerts all its powers in increasing the mass of the organs in which it resides; it therefore converts into blood all azotised parts of the food taken by the animal, except those which supply the small amount of waste. All the excess of blood is converted into flesh (*i.e.* muscular tissue and cellular tissue). The animal now becomes fleshy and plump.

The other constituents of the food, such as starch, sugar, and gum, are converted into fat, and deposited as adipose tissue. The cause of the deposition of fat is this—that sufficient oxygen does not enter the system to consume the food, or to convert it into carbonic acid and water; it is, therefore, only partially consumed, or, in other words, converted into fat (Liebig).^{*} Fat is not a part of the organism; it is a chemical compound, arising from an unnatural state. The fattening of cattle is similar to the growing of

^{*} This process may be familiarly compared to the manufacture of coal-gas. If we burn coal in the open air, carbonic acid gas and water are the only products of combustion; but if there be a deficiency of air, such as in the retorts for the preparation of gas, then the whole of the coal is not converted into gases, part being again obtained as coal tar. The tar formed in this case represents the fat of animals.

corn plants, or to agriculture generally. The object of agriculture is to produce an abnormal increase of some particular constituent of a plant, such as of gluten in the wheat. This we do by chemical means—by *manure*. The fattening of cattle is similar. Our object is to produce an unnatural increase of some particular parts of the body; and to do this we must put the cattle in an unnatural state.

Fat is not an organ possessing shape; it is not a substance peculiar to the animal economy. We find the fat of beef and mutton in cocoa-beans, of human fat in olive-oil, of butter in palm-oil, and of horse fat and train-oil in certain oily seeds (Liebig). In these the fat must arise, just as in animals, by the same chemical process of an imperfect transformation.

The most favourable conditions to the developement of tallow are food destitute of nitrogen, warmth, and want of exercise. We shall return to this subject again, but now may remark that warmth is perfectly indispensable to the production of tallow in an animal. Tallow is so easily consumed by the oxygen of the air that it is employed to produce animal heat, if there be any deficiency in this. Martell (*Trans. Linn. Soc.*, vol. xi. p. 411) mentions the case of a fat pig which was overwhelmed in a slip of earth, and lived for 160 days without food; and was found to have diminished in weight during that time 120 lbs. Its fat had been consumed in supporting respiration, just as that of hibernating animals during winter. Motion also diminishes the tendency of an animal to fatten, by increasing the number of its respirations, and therefore by giving to the system an increased supply of oxygen gas, which consumes the tallow. Hence our practice of stall-feeding cattle. But, before entering into the discussion of practical points, let us fully understand the principles involved in fattening.

First, then, let us inquire what are the phenomena which attend the production of motion in any animal. Liebig asserts, and we quite agree with him, "that every motion, every manifestation of force, is the result of a transformation of the structure or of its substance; that every conception, every mental affection, is followed by changes in the chemical nature of the secreted fluids; that every thought, every sensation, is accompanied by a change in the composition of the substance of the brain."

I have already stated that there is a constant conflict in the body between the two antagonist powers, Vitality and Chemical Affinity. In the state of health, Vitality retains the ascendancy, and subdues the Chemical powers; but this subjection is the result of much effort on the part of Vitality, for the strength of the rival forces is nearly equal. The moment, therefore, that Vitality leaves undefended a single point in the fortress of the

body, that moment the Chemical forces begin the work of demolition on the unprotected part. Thus, if Vitality be called upon by the superior power, Volition, to execute some purpose of its will—to move the arm, for example—the vitality residing in the muscles of the arm obeys this command, and occasions the desired movement. Before the production of motion, all its powers were exerted in preventing the encroachment of the chemical forces (*i. e.* of the oxygen of the air). But when it is employed in effecting a vital movement, such as that of the arm, it is no longer in a position to resist the attack of its antagonist power. This, therefore, immediately acts upon the muscles, which obey the will, destroys part of their substance, and occasions its separation from the tissues.

Probably none of Liebig's theories may appear so problematical as that which asserts that every manifestation of force, however trivial, is accompanied by a change of matter in the body. Yet there is no theory which can be more easily proved by reference to your own experience. You are well aware that poultry-feeders confine their poultry when it is necessary to fatten them quickly. The cruel practice of nailing the feet of geese to the ground during fattening is owing to the anxiety of avaricious feeders to prevent the expenditure of a particle of the food by the motion of the animal. The greatest part* of the food consumed by an animal thus deprived of the means of motion goes to the production of fat. When pigs are put up to be fattened, they are removed from the yard in which exercise is permitted, and placed in a narrow sty, with little room to move. A small amount of the food being now expended in the production of motion, the pig rapidly increases in size.†

* Not *all*, because the involuntary motions, such as those of the heart and intestines, still proceed, and the heat of the body has to be sustained by the combustion of a portion of the food.

† An excellent proof of this view has been kindly pointed out to me by Mr. W. Stace, of Berwick, near Lewes. The experiment was performed by Lord Egremont about the end of the last century, and is described in Young's *Survey of Sussex* in the following words:—

“As there were some hogs that we wanted to keep over the summer, seven of the largest were put up to fat on the 25th of February; they were fatted upon barley-meal, of which they had as much as they could eat. Some days after, the observation of a particular circumstance suggested the following experiment:—a hog nearly of the same size as the seven, but who had not been put up with them, because they appeared rather larger, but without weighing them, was confined on the 4th of March in a cage made of planks, of which one side was made to move with pegs, so as to fit exactly the size of the hog, with small holes at the bottom to allow the water to drain from him, and a door behind to remove the soil. The cage stood upon four feet, about 1 foot from the ground, and was made to confine the hog so closely that he could only stand up to feed and lie down on his belly. He had only two bushels of barley-meal, and the rest of his

When prizes formerly were given for animals overloaded with fat, without reference to symmetry of form, it was customary to feed the sheep in a narrow confined shed from which the light was excluded. The animals having no inducement to roam passed most of their time in sleep, and the food which they consumed served only to keep up the animal heat, and to increase the mass of the body.

Mr. Childers has made some beautiful experiments on this subject, the results of which have shown that sheep fed in sheds consume from one-fifth to one-half less food, and increase one-third more in weight, than those fed in the open field.* The cause of these results is twofold:—First, the sheep in the sheds are subjected to less motion, and therefore exhaust less food in its production than those in the field; and, secondly, the sheep are kept warm in the sheds, and therefore expend less food for the support of animal heat than those exposed to a cold atmosphere in the open fields.

We know how difficult it is to fatten oxen in June and July, when the flies annoy them, and disturb their repose. The food which they consume is exhausted in motion. This food, if the oxen were in a state of tranquillity, would increase the mass of the body. We know also that the harassing and worrying of sheep by dogs is fatal to their fattening.

There are numerous other proofs of our view. The Cornish miner, from the expenditure of force necessary in ascending and descending the ladder of his mine, together with the labour which he has to undergo whilst in it, is found in the evening to be several pounds lighter than in the morning. It is well known that the more bodily labour to which a man is subjected the more food must he receive to supply the tissues wasted in that labour. In the late distress in Lancashire, the poor sufferers, who often were unable to obtain sustenance for themselves and families, discovered, through the force of necessity, both the theories which we have endeavoured to expound, viz., that warmth is an equivalent for food, and that motion is always accompanied by a change of matter. We are informed by the daily press that whole fa-

food was boiled potatoes. They were all killed on the 13th of April, and the weights were as follows (8lbs. to the stone):—

The hog in the cage	13 st. 2 lbs.
The average weight of the other hogs, all of the same breed .	11 st. 3 lbs.
The hog in the cage was weighed before he was put in: alive 11 st. 1 lb.; he was kept five weeks, and then weighed alive 18 st. 3 lbs. He had two bushels of barley-meal, and about eight bushels of potatoes. He was quite sulky for the first two days, and would eat nothing."	

This experiment forms an excellent illustration of the theory that force is produced by an expenditure of matter.

* Trans. Royal Agric. Soc. of England, vol. i. pp. 170 and 407.

milies remained in bed for days together, covered with as many clothes as their small stock could furnish. In this state the animal heat was artificially retained, and little matter being expended in motion, a small amount of food was sufficient to support the vital principle.*

In the Scotch prisons there are three rates of diet assigned to the prisoners. The first, or lowest rate, is given to prisoners of a sedentary occupation, such as woolpickers; weavers, carpenters, and blacksmiths get the third or highest rate. In the latter case, the force employed being greater than in the former, more food is necessary for the production of that force.

A cavalry horse, in ordinary service, is furnished with 8 lbs. of oats per diem; but when in active service, 10 lbs. of oats are given to it.

The flesh of a stag hunted to death is unfit to eat, and is, when caught, in incipient putrefaction; because the force expended in running has occasioned a destruction of the tissues of the body. For a similar reason the flesh of a hunted hare is peculiarly tender; and it was a barbarous custom in former times to render bacon delicate by whipping pigs to death.†

Epilepsy is always accompanied by an exaltation of force, and hence we find that a patient suffering under that malady becomes rapidly emaciated; just as sheep do when afflicted with the same disease.

In all these cases motion or force is produced without food, and

* As a striking contrast to the above, we may cite another example of the same fact. All travellers have remarked with surprise that Englishmen in hot countries are more fond of violent games than they are accustomed to in England. The reason is obvious, when we consider the theories already stated. In Italy the air is much expanded, and therefore a small amount of oxygen enters the system at each respiration. But the Italians live upon food containing a very small proportion of carbon, so small that the inspired air is sufficient to effect its combustion, and the temperature of the external air retains the warmth of the body. The Italian is therefore indolent, and loves to enjoy his siesta. But in India it is very different, for here we find the violent games of golf and rackets resorted to; whilst dancing forms a favourite amusement in the evening. With the usual prejudice to custom which distinguishes the Englishman abroad, he continues to live in India as he did in England. He partakes of heavy dinners, consisting of food with a large amount of carbon. But the expanded air prevents the combustion of this, and consequently he is obliged to resort to violent exercise to increase the number of his respirations, and to accelerate the transformation of the tissues of his body.

† Another excellent example, in proof of this principle, has been kindly pointed out to me by the Earl of Essex. Before cattle are killed in Rome, it is the custom to drive them round the walls of the city at a rapid pace. A driver on horseback follows with a kind of spear or goad, in order to accelerate their running. They are thus put in the position of a hunted hare or stag, and their flesh acquires the tenderness which is desired by the butcher. In all these cases an artificial state of decay is excited.

therefore at the expense of the tissues of the body. Sportsmen who are accustomed to wander over the moors without food must have observed a sedimentary deposit in their urine. Exactly the same deposit (uric acid) takes place when a patient is afflicted with fever.* The cause is the same in both,—that in the absence of food the tissues of the body are transformed in production of force, and at the same time oxygen is not respired in sufficient quantity to convert the waste matter of the tissues into urea.† (Liebig.)

If, then, it be admitted that practice confirms theory in asserting that animal heat arises from a combustion of food, and that the production of force, or, in other words, of *motion*, is always accompanied by a change of matter in the body, we are prepared to apply these two great laws in their practical applications. And to save misconception, I distinctly state at the outset, that any suggestions which may arise from consideration of the theories of fattening must be received by you with caution, and looked upon by you with suspicion, as the suggestions of a man with a deficient knowledge of practice. But if, on the other hand, you find that practice unites with science in establishing the truth of these theories, then I may solicit a fair hearing for the suggestions which they naturally produce.

I shall divide the remainder of our subject into four parts:—

- 1st. The food of cattle.
- 2nd. The rearing and fattening of cattle.
- 3rd. The feeding of cattle for dairy purposes.
- 4th. An attempt to explain the “fattening points” of cattle, and the causes of the peculiar aptitude to fatten possessed by various breeds.

Food of Cattle.—It has already been shown that there are two kinds of food. The first, which contains nitrogen, is exactly of the same composition as the principal tissues of the human body, and is the only substance which can supply the waste of these tissues. The second kind of food is that destitute of nitrogen, such as starch, gum, and sugar, all of which are destined for the support of respiration and consequent heat of the animal. The latter kind of food, when in excess, is converted into fat, but never into muscle. The increase of flesh in an animal consists in two changes of the matter of the food, without any alteration in its composition. The albumen or nitrogenous constituent of the food is first converted into blood, without decomposition, and the

* Fever consists in an exaltation of force, and is generally accompanied with loss of appetite; the tissues must therefore furnish the change of matter necessary for the production of force.

† Urea is the usual state in which the waste nitrogenous matter of the body is expelled from the system.

blood is afterwards converted into flesh. In order to show that the transformation is actually effected without change, we refer you to the composition of albumen, blood, and flesh, as ascertained by the accurate analyses of different chemists:—

	Vegetable Albumen.		Ox Blood.		Flesh.	
	Scherer.	Mulder.	Playfair.	Boeckman.	Playfair.	Boeckman.
Carbon .	55.160	54.99	54.35	54.36	54.12	54.18
Hydrogen	7.055	6.87	7.50	7.67	7.89	7.93
Nitrogen	15.966	15.66	15.76	15.77	15.67	15.71
Oxygen .	21.819	22.48	22.39	22.20	22.32	22.18

Now, as flesh can only be formed from substances of its own composition, the value of different kinds of food will vary according to the quantity of albumen contained in it. Boussingault many years since endeavoured to lay down the principle that the value of a particular kind of food depended upon its proportion of nitrogen.* This principle was rather arbitrary; because, although it may be true enough as far as regards flesh, it is quite erroneous as regards the production of tallow or the support of respiration. Boussingault's generalization arose from an ignorance of the functions of the constituents of food destitute of nitrogen. Farmers have always been very anxious to obtain a correct list of the equivalent values of various kinds of food, but have never yet succeeded. Mr. Rham has compiled a list† from the experiments of the most distinguished agriculturists; but it is impossible to rely upon equivalents obtained by mere experiment. The reason for this assertion will be obvious, when it is considered that the quantity of food necessary to keep an animal in a certain state must vary according to the conditions in which it is placed, *i. e.*, according to the temperature to which it is exposed, and to the amount of exercise which it receives. In a hot day it will require much less food than in a cold. Equivalents of food may be correct, as far as the same animal is concerned, when it is placed in the same conditions; but they can be of little value as regards other animals, because, as we shall afterwards show, the size of the lungs of an animal occasions a great difference in the amount of food consumed.

It is very important for us to know how much water each kind of food contains. Thus in giving a pig 100 lbs. of potatoes, we actually give it only 28 lbs., because 72 lbs. of this food consist of water. The following table, drawn up from analyses made by myself, exhibits the amount of dry organic matter contained in the most usual kinds of food:‡—

* *Annales de Chimie et de Physique*, lxiii., 225.

† *Journal R. E. Agric. Soc.*, vol. iii. p. 79.

‡ The analyses of swedes, turnips, mangold-wurzel, potatoes, and carrots are made upon samples procured from the field, and not upon stored

		Water. lbs.	Organic Matter. lbs.	Ashes. lbs.
100 lbs. of peas	contain	16	80½	3½
„ beans	„	14	82½	3½
„ lentils	„	16	81	3
„ oats	„	18	79	3
„ oatmeal	„	9	89	2
„ barleymeal	„	15½	82½	2
„ hay	„	16	76½	7½
„ wheat-straw	„	18	79	3
„ turnips	„	89	10	1
„ swedish turnips	„	85	14	1
„ mangold-wurzel	„	89	10	1
„ white carrot	„	87	12	1
„ potatoes	„	72	27	1
„ red-beet	„	89	10	1
„ linseed-cake	„	17	75½	7½
„ bran	„	14	81	5

In estimating the equivalent value of various kinds of food, we must take into calculation the amount of water contained in them. Mr. Rham states* that 100 lbs. of hay are equal to 339 lbs. of mangold-wurzel; but in 100 lbs. of ordinary hay there are contained only 76 lbs. of dry hay, and in 100 lbs. of mangold-wurzel only 10 lbs. of that root. So in reality we find that 34 lbs. of dry mangold-wurzel equal 76 lbs. of hay. Thus the equivalents become completely reversed, and dry mangold-wurzel is seen to possess considerably more than double the equivalent of dry hay.

It may often be a question of practical importance, whether it might be advisable in cold weather to mix with the roots, upon which oxen or sheep are fed, a certain quantity of some other food containing a less proportion of water.

To illustrate our meaning, we will take the case of an ox fed upon mangold-wurzel, as described by Earl Spencer.† The ox consumed between the 24th of December and 23rd of January, 1848 lbs. of mangold-wurzel, or in round numbers, 60 lbs. daily.‡ By reference to the preceding table, it will be seen that the ox in this quantity received 53½ lbs. of water and only 6½ lbs. of dry mangold-wurzel. Let us assume that, during the above cold months, the average temperature of the air was 32°. In this case the 53 lbs. of water taken in the food had to be raised to the temperature of the animal (98°). To effect this, 2 oz. of carbon, or ⅓ of the whole quantity contained in the food, are necessary to

roots. The table is of use in showing us what we remove from our land. Thus suppose we cart from 3 acres 100 tons of turnips, we actually remove 89 tons of water, 1 ton of mineral matter, and only 10 tons of dry turnips.

* Journal, vol. iii. p. 79.

† Journal, vol. ii. p. 297.

‡ 60 lbs. ordinary mangold-wurzel contain 45 ounces of carbon.

elevate it to the proper temperature of the body. This quantity of carbon corresponds to nearly 3 lbs. of mangold-wurzel. The actual loss is, however, very much greater than this, as much of the water is converted into vapour at a great expense of heat.

In feeding pigs we endeavour to avoid this loss as much as possible, by giving them little water and very dry food. Those who feed pigs are well aware of the fact, that they thrive more rapidly on dry than on wet food. The explanation of this fact has now been given.

As muscle is formed only by the gluten or albumen of the food, which albumen is in reality flesh itself, we can ascertain the comparative value of food, as far as the production of muscle is concerned, by estimating the exact quantity of the nitrogenous constituent of the food. The following table has been constructed by estimating the quantity of nitrogen in the food, and multiplying this by $6\frac{1}{4}$; the product is the quantity of albumen.* This method is far more exact than the mechanical process proposed by Sir Humphry Davy, which the progress of organic chemistry has shown to be insusceptible of accuracy. The analyses used in the production of the table have been made by Boussingault and myself. When I found that my analysis differed considerably from that of Boussingault, I have taken the mean of both of our analyses, on the presumption that this will give a fairer indication of the average value of food, as the amount of nitrogenous matter varies, according to the state of cultivation. Nearly all the kinds of food analysed I have procured from Lord Ducie's farm at Whitfield, and they were selected as fair average specimens. In all cases the table is drawn out in correspondence with the preceding table of the quantity of water and ashes. When these are added to the quantity of albumen, which we find by analysis, and the combined number subtracted from the whole quantity of food, it is obvious the remainder must be the unazotized part of the food: this being known, we are in possession of approximative, though not perfectly accurate, information relative to the value of the food for the support of respiration and production of fat:†—

* The analyses which form the foundation of this table are given at the end of the lectures.

† The second column is only intended to serve as a rough temporary approximation. Professor Liebig is engaged in examining this subject in detail, and will furnish a more accurate mode of determining this point. Azote and unazotized are synonymous terms with nitrogen and unnitrogenized. I have delayed giving the analyses of Swedish turnips and mangold-wurzel, because I find them to vary in their value according to the soil in which they grow. I shall, however, publish the analyses, after a more extended examination.

100 lbs.	Albumen. lbs.	Unazotized Matter. lbs.
Flesh . . .	25	0
Blood . . .	20	0
Beans . . .	31	51½
Peas . . .	29	51½
Lentils . . .	33	48
Potatoes . . .	2	25
Oats . . .	11	68
Barley meal . . .	14	68½
Hay . . .	8	68½
Turnips . . .	1	9
Carrot . . .	2	10
Red-beet . . .	1½	8½

A few considerations will show that it is quite impossible to draw up any series of numbers to represent the equivalent values of the food; for we must first know the object for which the food is intended. The numbers in the first column, representing the gluten, are actually the equivalent value of the various foods, as far as flesh is concerned; but they yield no indication of the power of the food to form tallow. The second column, on the other hand, furnishes a rough approximation on the latter point, whilst it gives no indication of the former. In a cold day the animals ought to be furnished with food containing a considerable amount of unazotized ingredients, in order to protect them from the effects of the cold. The equivalent values of potatoes and beans could not be compared, because their respective value as food arises from totally different causes. Potatoes are of great use in keeping up the heat of the body and in forming tallow; but are in the highest degree unprofitable for forming flesh. It will be seen by the table, that 1550 lbs. of potatoes would be required to form the same quantity of *flesh* that 100 lbs. of beans would do; whilst little more than 200 lbs. would suffice to form the same quantity of tallow: hence the great advantage of mixing food so as to supply in smaller bulk those constituents of which one kind of food is deficient. Sheep fed on oil-cake increase in weight faster than on any other kind of food, but they feel quite soft, and when fat handle like a bag of oil. This is because they receive food which contains very little albumen to form flesh, so that tallow is the only product.* But if with the oil-cake they receive oats or barley, they are firm to the touch and possess plenty of good flesh, and the fat lies equally distributed amongst

* Oil-cake owes its fattening properties partly to its oil, but principally to its mucilage. When oil-cake is put into water, it dissolves into a thick gummy mass.

the muscular fibre. The reason here also is obvious; for both oats and barley contain much albumen.*

In an experiment made by Mr. Morton at Lord Ducie's farm, twenty-eight pigs put up in pens of seven each, and fed on an average on $15\frac{1}{2}$ lbs. of potatoes and 4 lbs. of barley-meal each, gained 15 or 16 lbs. weekly. In this quantity the pigs actually consumed nearly equal quantities of the two kinds of food, or exactly 30 lbs. of *dry* potatoes and 23 lbs. of dry barley-meal weekly. The increase in weight being 16 lbs. for each pig, 37 lbs. of the food were lost in supporting respiration and the necessary muscular movements, even without taking into calculation the water contained in the flesh of the animal, which amounts to 75 per cent. If these animals had been deprived of muscular movement by being placed in narrow warm cribs, it is reasonable to suppose that less food would have been lost, because less would have been consumed in the production of force and in sustaining the animal heat. The barley-meal contains the constituents for furnishing firm flesh, as well as for producing tallow, or supporting respiration. The economy of using potatoes consisted in their supporting the respiration of the animals at less expense than barley. The 108 lbs. of potatoes used in the week for this purpose and for the production of tallow contain 26 lbs. of unazotized matter. In order to replace this, 33 lbs. of barley-meal would be requisite. It does not invalidate the conclusion that 33 lbs. of barley-meal would produce a greater return than 108 lbs. of potatoes, because the former contains much more albumen and less water than the latter.

The supposition that fat is produced by an imperfect combustion of the unazotized parts of food has within these few weeks been disputed by Dumas. This celebrated chemist affirms, in opposition to Liebig's view, that many kinds of food contain fat ready formed, and that to this fat is due the tallow of animals, just as their flesh is to the gluten of the food. He affirms, for example, that hay contains 2 per cent. of fat, and maize or Indian corn 9 per cent. of the same ingredient.† He then enters into

* Chemically speaking, they do not contain albumen, but gluten. All the nitrogenized ingredients of food being of the same composition, I employ for them one term. This is *chemically* wrong, but *agriculturally* correct.

† According to more recent analyses of Liebig, hay contains 1.56 per cent., and maize 4.67 per cent. of fat. Braconnot found 1.20 per cent. in peas, while Fresenius got 2.1 per cent.; and in lentils 1.3 per cent. Vogel obtained 2.00 per cent. of fat in oats; Liebig, 0.3 per cent. in dry potatoes; and Braconnot, 0.13 per cent. in rice, although, in another variety, Vogel states that he detected 1.05 per cent. The substance here called fat is in reality a waxy or resinous body, and not tallow, except in a few instances.

calculations to show that this fat is more than is necessary to account for the increase of tallow in an animal. He contends further, that the tallow of the food may be found completely in the milk of a cow fed upon it. In such a case he considers that none of it is lost. But even admitting this to be correct, M. Dumas must suppose that some digestive process converts the tallow into butter, for the composition of the fat found in vegetables is quite different from the butter of the milk. The conception of a digestive process is, therefore, quite as indispensable in his theory as in that of Liebig. I have shown, in a memoir read before the Chemical Society, that the fat contained in food does not account for half the butter in the milk of a cow, even conceding that it is all transformed into butter.

We know that fatty substances are of use in fattening animals. Mutton-suet is often given to fattening ducks. Linseed-oil is occasionally given as a substitute for linseed-cake. There cannot, then, be the smallest doubt that fatty matters are capable of producing tallow in the body, but it is impossible to admit M. Dumas's opinion in all its generality. We know that sugar is a substance which occasions a great development of tallow; but surely it cannot be affirmed that fat exists in it ready formed? Rice given to fowls causes them quickly to be covered with fat, yet rice contains very little fat.

We therefore do not see any reason to depart from the opinion of Liebig that fat is the product of a peculiar digestive process on the unazotized constituents of food.

The *form* in which the food is given to cattle is far from being a matter of indifference. If the food be in a state in which it is either difficult to attain, or difficult to masticate when obtained, much of it will be lost in the production of force necessary to adapt it for the organs of digestion. The cutting of hay and straw to chaff is unwittingly done with a view to prevent any unnecessary expenditure of force. Less mastication is requisite, and consequently less of the tissues of the body are expended in grinding down the food. The use of saliva, according to Liebig, is to form a receptacle for air or oxygen, by which means it is mixed with the food and carried to the stomach. The use of mastication, then, is not only to comminute the food, but also to mix it with air or saliva. We find that a larger size of chaff is given to those animals which chew the cud than to those that do not. One great object of rumination is to obtain a repeated supply of oxygen to the food. Hence, in our ordinary practice, we cut the hay-chaff 1 inch in length for oxen, $\frac{1}{2}$ inch for sheep, and only $\frac{1}{4}$ inch for horses. The two first being ruminating animals require it longer than the horse, which is not one. When we consider that fresh grass is much more easily masticated than

hay, the economy of force exhibited in cutting the latter is well judged.

I am quite aware many farmers entertain the opinion that cutting hay is only of use in the facilities which it affords for mixing with the hay straw or other inferior fodder. Straw, except when new, is not a very nutritious food, for we find a great part of it unchanged in the fæces of the animal fed upon it. Its principal use is to give a bulk to the food taken. Even in the case of turnips, a food of considerable bulk, straw is necessary, because they contain nearly 90 per cent. of water, which becomes soon separated. Thus it is that cattle fed upon turnips voluntarily take 2 or 3 lbs. of straw daily, or as much as will serve to give the necessary bulk to the food. The digestive process of herbivorous animals is very complicated. The food is primarily taken into the first stomach or rumen, which is analogous to the crop in birds. Here it is moistened with a secretion from the stomach. The coarse unmasticated food is from thence transmitted into the second stomach, or reticulum, where it is rolled up into little balls, one of which from time to time is returned to the mouth to be further comminuted and insalivated. After this reduction, it is sent into the manyplus or third stomach, where it is further reduced to a pulpy mass, and in this state enters the fourth stomach, where true digestion commences. The object of the three first stomachs being merely to obtain a proper comminution of the food, it is necessary to have that food of sufficient bulk, otherwise the peristaltic motion of the stomach would be impeded. This would appear to be the reason for giving straw with turnips and other kinds of succulent food. The expression of the farmer is "that straw corrects their watery nature," which means, increases their bulk when their water has left them and reduced their volume. Rumination is requisite in order to keep an ox in health. A little straw or hay is accordingly necessary to enable it to chew the cud. We know a case in which barley-meal and boiled potatoes were given to cows without hay or straw. Constipation resulted, and the cattle nearly perished from the ignorance of the feeder.

From these considerations we are induced to consider that a greater return will be made by food partly but not too much reduced. The turnip-slicer is known to save food, and this arises from the fact that the sheep expend less force in eating sliced than whole turnips, and to their being enabled to lie down more constantly. On similar grounds are we to ascribe the advantage of steaming food, or reducing it to the state which the first three stomachs would otherwise have to do at a great expenditure of force, and consequently of food to produce it.

I am desirous of explaining to you on rational grounds your

own practice, without entering into your domain of practically applying the theories; which I am sure you yourselves can do much better than I can, and with less risk of error. I therefore recommend to your own consideration whether improvements in practice may not be made from the principles now developed.

But, before leaving the consideration of food, it may be advisable to explain to you the effects which common salt produces on the animal economy. You are all aware of the practice of giving salt to cattle, and of its beneficial effects. I have mentioned repeatedly that respiration is carried on by means of the combustion of those constituents of the food which are destitute of nitrogen. But before this combustion is effected, they are transformed by the liver into the fluid called *bile*. Bile is a compound of the alkali soda, with a resinous or highly carbonaceous substance derived from the food. The bile, after being formed, is absorbed by certain vessels of the intestines, and there meeting with oxygen, is consumed and converted into carbonic acid and water, which are expired by the lungs. The combustion does not take place in the lungs themselves, as is generally supposed, but in the intestines. For this theory we are also indebted to the great German chemist. The manner is very curious in which the carbonic acid is carried up and expired by the lungs. All blood contains iron. There are two principal states of oxidation of this metal—viz. the peroxide and the protoxide. The former yields oxygen very readily to organic matter, and occasions its conversion into carbonic acid and water; but in doing so, it is reduced to the state of protoxide, which oxide has a great affinity for the carbonic acid thus formed: it unites with it, and is carried up by the venous blood to the lungs as carbonate of iron. There it comes in contact with the oxygen of the air. But the moment carbonate of iron is acted upon by oxygen it is decomposed, peroxide of iron being again formed; whilst the carbonic acid is set at liberty, and is expired by the lungs. The peroxide of iron in the arterial blood executes its function anew, as carrier of carbonic acid to the lungs.

Now as bile is the medium through which respiration is supported, it is necessary that it should be properly and regularly formed. This can only be done by supplying the animal with a constant amount of soda: this we do in common salt. The soda of the salt aids in the formation of the bile, whilst its muriatic acid assists the digestion of the food. A proper formation of the secretions is necessary to the health of an animal, and a supply of salt is highly favourable to their production.

But, whilst it is admitted that a limited supply of salt is very useful to the health of the animal, a large supply is highly prejudicial, and prevents the formation of fat. An experiment was

tried upon a goose, which was crammed with maize, and allowed to eat salt. The salt taken by the goose was less than that necessary to produce a purgative action, and yet the goose did not fatten. This arose from the excess of food being formed into bile, and not into fat. As much bile was consumed as corresponded to the oxygen inspired, whilst the remainder passed out with the excrements, and was detected therein.

On this account it is a bad practice to give fatting sheep as much salt as they will take in summer. Sheep, if I am rightly informed, are very fond of salt in summer, but do not take so much in winter. The reason of this is, that these animals eat more food in hot weather than the oxygen respired suffices to consume—they, therefore, find it agreeable to carry off this excess of food; this is done by salt, in the manner now described. A small quantity tends to their general health, and to the activity of their digestive apparatus; but a large quantity, though also favourable to the health of the animal, is detrimental to the farmer by preventing a proper return of the food which he supplies. In winter, sheep do not find salt so agreeable, because the greater condensation of the air occasions a more rapid transformation of the food. We will again advert to the use of salt when treating of the dairy.

XX.—*Second Lecture on the Rearing and Feeding of Cattle.*
By LYON PLAYFAIR. Delivered to the Society, December, 1842.

I. THE ordinary state of health of an adult animal consists in keeping the supply equal to the waste of the tissues of the body. When the supply is either greater or less than the waste, it is certain that the nutrition of the animal is effected under unnatural conditions.

But the process of nutrition is different in a young animal. In youth the supply must be greater than the waste of the body, otherwise an increase in the mass of the body could not be produced. The life of an adult consists in the sustenance of the tissues already fully formed; while the life of a child includes the increase and development of the tissues. The principle which produces this increase has been termed the “vegetative life” of the animal. It merely consists in an increased ascendancy of vitality and subjugation of causes of waste or the chemical forces.

The respiratory apparatus of a young animal is more active than in an adult, and consequently a greater amount of oxygen enters its system; a fact which is attested by the temperature of its body being higher than that of its parent. As this oxygen

cannot again be separated from the body without being in union either with carbon or hydrogen, it is indispensable that both of these elements should exist largely in the food of the young animal. But it is quite as indispensable that the food should contain materials fitted for the increase of its growing frame. Both these conditions are united in the milk of the mother. I subjoin the composition of the milk of several animals :—

	Woman.* Playfair.	Cow.† Playfair.	Ass.‡ Peligot.
Casein . . .	1·54	4·0	1·95
Butter . . .	4·37	4·6	1·29
Sugar of milk .	5·75	3·8	6·29
Ashes . . .	0·53	0·6	..
Solid matter .	12·19	13·0	9·53
Water . . .	87·81	87·0	90·47
	100·00	100·0	100·0

Casein is precisely the same in composition as animal flesh, and hence supplies matter adapted for the growth of the body. Butter and sugar are destined for the support of respiration, and consequent maintenance of animal heat. Butter is a substance admirably suited for this purpose ; for, being of a combustible nature, it yields much heat by its union with oxygen. Sugar also is well adapted for the support of respiration, from causes which I explained in my former lectures. The milk of the ass is very similar in composition to that of woman ; both are remarkable from their large proportion of sugar. The milk of the cow contains more casein and butter, and less sugar, than that of either of the previous animals. The ashes of milk consist principally of common salt and the earth of bones. It also contains potash and oxide of iron. The soda of the common salt is necessary for the formation of bile, as I stated in my last lecture, whilst its muriatic acid aids in the process of digestion.

In milk, therefore, we find united all the conditions for the life of a young animal. Its rapid respiration, and the high temperature of its body, are supported by the butter and sugar of the milk. The casein furnishes matter for its growth, and the ashes the materials for the formation of the bones, and necessary constituents of the blood.

* The milk was taken from a farmer's wife, a strong healthy female, of twenty-eight years of age. The specimen analysed was obtained on the twenty-first day after her confinement, the child being her third ; her food consisted principally of gruel. She was confined to bed ; and on this account the casein may be in smaller quantity than usual, and the butter in excess.

† The analysis of the milk of the cow is the average of several analyses of milk taken when the cow was in the field.

‡ Peligot, *An. de Ch. et de Phys.*, vol. lxii., p. 432.

Casein, although of the same composition as vegetable albumen and gluten, differs from them materially in its properties. It is soluble in water, and does not coagulate by heat. Such properties obviously fit it for the nutrition of a young animal, in whom the organs of digestion are not yet matured.

The young ruminant, subsisting on the milk of its mother, does not require that complicated system of stomachs which afterwards becomes necessary for the proper comminution of its food. Accordingly we find that the aperture of the first and second stomach is entirely closed, and the folds of the third adhere together so as to form a narrow tube. The milk passes at once into the fourth stomach, which is the seat of true digestion. This arrangement of itself indicates that the food of the young animal ought to be liquid, even when it is deprived of the milk of its parent. It is for this reason that the weaning of a calf must take place very gradually.

There cannot be the slightest doubt that the future health and constitution of the adult in a great measure depends upon its judicious and generous treatment when young. Nature has pointed out to us, in the milk of the mother, not only the proper food of the child, but has exhibited also in it the model after which all food should be prepared. I do not mean that the adult should receive the various constituents of its food in the same proportion as the child, but that none of these constituents should be absent. In the milk of the cow, the amount of unazotised matter, or of the part of milk destined for the support of respiration, is only about double that of the azotised portion, or of that part which forms flesh. In the food of adult cattle the proportion of the former to the latter is about six to one. But the unazotised constituents of the food of adults consist principally of starch, sugar, and gum, whilst those in the food of children consist of butter and sugar. The butter contains a very large amount of carbon and of hydrogen, and, therefore, a less quantity of it suffices to sustain the heat of the body than of any of the other substances now mentioned. Thus milk is actually better adapted for the support of the rapid respiration of a young animal than other kinds of food. The large proportion of casein in milk is obviously indispensable to furnish materials for the rapid increase of the body.

Any interference with the order of nature in the rearing of young stock is improper. But it sometimes occurs in England that calves are allowed to suck only for a few days, and afterwards are fed upon skimmed milk. In separating cream from milk, we remove most of its butter, as well as part of the casein. Skimmed milk is therefore destitute of the principal ingredient destined by nature for the support of respiration and sustenance

of the temperature of the body of the young animal. The proportion between the unazotised and azotised matter is completely altered, and the nutrition of the animal is placed in an unnatural condition. This is far from being an universal practice. Earl Spencer, to whose judgment on this point we cannot pay too high a deference, feeds his calves for three months on unskimmed milk, and afterwards on skimmed milk, to which he adds the meal of oats or of barley.* In this practice, which forms a striking contrast with the preceding, we find that, even when it is considered necessary to withdraw the butter from the milk, the proportion of food fitted for the support of respiration is compensated by the increased amount of unazotised matter in the meal with which it is mixed.

Although it is a very false economy to stint the allowance of food to a young animal, there may possibly be certain cases in which the same liberal allowance cannot be given, as in the case now mentioned. The demand for milk has made the farmer very desirous to discover certain substitutes for that valuable fluid. The late Duke of Northumberland prepared skimmed milk with treacle and linseed oil-cake, and it is stated that this mixture has been found to succeed.† Here the sugar in the treacle, with the fat and gum of the oil-cake, served to compensate for the cream removed from the milk. Cream, however, contains also a quantity of casein, which is not supplied in this mixture. Bruised flax-seed,‡ and an infusion of hay,§ have been added to skimmed milk for a similar purpose.

On this subject it may be worthy of remark that the only kind of food in which casein exists is that derived from leguminous plants, such as beans, peas, and lentils. When bean-flour is softened and ground up with water, and the infusion passed through a sieve, the water is found to contain casein, fat (butter), and starch. The latter deposits by standing; and the infusion has now all the characters of skimmed milk, as in fact, with the exception of sugar of milk, and butter, it is precisely identical with it. The addition of some fatty and gummy matter (as an infusion of linseed-cake) would more nearly approximate it to the composition of ordinary milk. And it is well worthy of remark, that in several districts of England, and in many of Scotland, pea or bean soup is very frequently given to young calves.

I merely put this forward in a chemical point of view, my

* Earl Spencer has found that sago forms an excellent mixture with skimmed milk for weaning calves. The sago, principally starch, forms an equivalent for butter.

† Dickson's Practical Agriculture, vol. ii., p. 987.

‡ Annals of Agriculture, vol. xxiii.

§ New System of Husbandry, vol. iii.

object being to explain principles, and not to recommend changes in practice of which I may be ignorant. I therefore distinctly protest against such a construction of my statements. If the farmer be obliged to find some substitute for his milk, I only recommend so far, that he will carefully examine the composition of milk, as already given, and the composition of the various kinds of food, and in his substitute arrange the materials of which it is composed as nearly as possible after the great type which nature has given to us. It ought not to be forgotten that the casein of milk and beans differs from the albumen found in other kinds of food, by its solubility in water. This solubility must serve some purpose in the nutrition of the young animal. Milk, peas, and beans, all containing casein, are found to be highly favourable in the early stages of fattening pigs, as it is said to keep a young hog growing; while meal is preferred towards the end, being, as it is termed, more "forcing," or, in other words, because it contains more ingredients fitted for the production of tallow. These facts show a similarity in the action of milk and of leguminous food which should not be lost sight of by farmers.

As the growth of an animal depends upon the activity of its vital powers, it must be obvious that every care should be taken to sustain and increase these. Exposure to cold diminishes the energy of vitality (the cause of increase), and elevates that of the chemical powers (the cause of waste). And this view is consonant with experience; for it is well known that young stock do not thrive well unless protected from cold. The state of *health* consists in an ascendancy of vitality over chemical affinity. Young stock should not be treated in a manner similar to fattening cattle; because, as we shall afterwards show, fattening consists in producing an unnatural condition. The great object, then, in rearing young stock is to obtain a proper development of all the organs of the body, and this can only be done by furnishing them with a rich, generous diet, with a proper degree of exercise, and by keeping them warm and dry. If every endeavour be not made to cherish the vital powers in youth, the chemical forces, ever ready to destroy the parts insufficiently protected by vitality, will prevent or retard the proper development of the body. Vitality must therefore be furnished with the proper materials (casein, albumen, &c.) to rear the structure of the body. Its powers must be sustained by keeping the body of a proper temperature by means of food adapted for the support of respiration, aided by external warmth; and the organs in which it resides must be rendered more fit for its habitation by their proper exercise.

The great point, then, in the rearing of stock is to take care that the vital powers are always predominant over the chemical.

Attention to these considerations will easily point out the kinds of food which are best adapted for a growing animal. Thus potatoes, without an admixture with other food, would be highly improper, because they do not contain sufficient albumen to supply the materials necessary for the growing frame. But it would be quite proper to mix potatoes with other food rich in albumen, for its starch might support the respiration and heat of the animals with more economy than another food containing much albumen but a less abundant supply of substances fitted for respiration.

It is a mistake into which many breeders fall to deprive the young animal of exercise by confining it entirely in the stall. Such a procedure is perfectly correct with a fattening calf, but not with one which is rearing. The muscular apparatus of a young animal requires a certain degree of exercise, without which it cannot increase. Unless the vitality residing in the various organs be called into action, it becomes enfeebled; and as vitality is the cause of increase in the body, any diminution of its power is highly prejudicial to growth. The amount of exercise must of course vary with the age of the animal. A child at the breast sleeps twenty hours of the day, and consequently wakes only four. The vitality being in the ascendancy during sleep, the mass of the body rapidly increases. The limbs of a young child are not adapted for its support, and hence it is unnecessary to exercise them. But a calf or a sheep possesses limbs fitted for a certain amount of progression, and by permitting their due exercise the health of the animal is sustained. But whilst we should endeavour, in the rearing of cattle, to use every means to keep the animal in its normal state of health, our treatment must be entirely different when we desire to fatten the same animal.

II. In my last lecture I endeavoured to convince you of Liebig's theory, that every motion, however trivial, is accompanied by a waste of matter in the body. I proved to you also, by reference to your own experience, that the heat of an animal is supported by a combustion of the food which it consumes; and consequently that more food is necessary in cold than in hot weather. I cited in proof of this the beautiful experiments of Earl Ducie and Mr. Childers, and, in further confirmation of the same fact, I may bring forward the evidence of Mr. Morton, who assures me that "sheep will consume more turnips in the cold wet days of winter than when the weather is dry and warm, and in frosty weather than in mild, dry weather; and the difference in their consumption," Mr. Morton states, "I find to be equal to one-fourth of the whole of their food."* Mr. Pusey also informs me that a farmer

* Answer to a question sent.

of great practical experience assured him that pigs fatten faster in summer, with the same food, than they do in winter.

But after the facts which I have had the honour of laying before you on a former occasion, I trust that further proofs are unnecessary. If then you admit that warmth is an *equivalent* for food—for the acknowledgment that animal heat is produced by the combustion of food is tantamount to this admission—then you must at once see the advantage of protecting a fattening animal from the cold. Anything that tends to cool the body of an animal is equivalent to a *waste* of food. All practical farmers allow that warmth is favourable to the fattening of cattle, though very few act up to the principle implied in this admission. We have seen that the saving of food occasioned by the partial protection of a shed, in the experiment made by Earl Ducie, amounted to one-fourth of the whole food; and in the second series of experiments of Mr. Childers,* where motion was at the same time prevented, the saving amounted to as much as one-half. Would it be worthy of trial whether covering stall-fed cattle with something warm, in a manner similar to horses, might not lead to beneficial results?

In whatever way warmth be given to fattening animals, it is certain that nothing will conduce more to the economy and profitable return of the food. It is the protection from cold which constitutes one of the advantages of stall-feeding.

Another great advantage obtained by stall-feeding is the deprivation of exercise. We have already stated the true state of health of an adult animal is, that the supply of food to the body should be equal to, but should not exceed, the waste of matter expended in the production of motion.† This is not the state desired in a fattening animal. We wish a diseased condition, or the state in which the increase of the body is far greater than the waste. We can best throw an animal into this condition by removing or diminishing the causes of waste.

Now the primary cause of waste is the oxygen of the air. It only acts, however, on the tissues of the body, when they are undefended by the antagonist power, vitality. This occurs, as we have repeatedly explained, when a vital movement is effected. During motion the number of respirations of an animal is increased; and accordingly the system receives more oxygen, which never again escapes from it without carrying away either part of the body or part of the food which has entered the body. Hence, by depriving an animal of motion, we diminish the number of its respirations, and consequently the cause of waste, and we husband the powers of vitality. We have already shown that the vitality

* Journal, vol. i. p. 407.

† This state is exhibited in a healthy adult man, who is found to weigh the same at the end of the year as he did at the beginning.

of a plant is wholly engaged in increasing the mass of its substance, and that none of it is expended in executing the commands of volition. In stall-feeding cattle we impart to them a *vegetative* life. The vitality of the animal in its natural or wild state is principally employed in executing vital movements, but in the stall these are in a great measure prohibited. Now this mysterious principle of life is never at rest. Its powers are, therefore, employed in increasing the mass of the body in which it resides.

Whilst pigs are growing, they are permitted the use of a yard; but when it is desired to fatten them, they are confined to a sty. This confinement is to prevent any waste of matter in the production of motion. Some even confine the pigs in sties so narrow that they are unable to turn, and as dark as possible, in order to induce them to sleep. Most farmers are aware of the fact that young calves, sheep, and pigs fatten more quickly in the dark than in the light. The explanation of this fact is simply this, that they pass more of their time in sleep. Sleep is that portion of the life of an animal when the principal growth of its body takes place. In sleep all the voluntary motions cease: vitality, therefore, now increases the mass of the body, as its force is not expended in producing motion. It is for this reason that we like those lethargic pigs which stagger to the trough in a lazy way, and sleep as soon as they have finished eating. Very little matter being expended in motion, they rapidly increase in size. The phlegmatic Chinese or Neapolitan pig fattens quickly, whilst the unimproved, long-legged Irish pig, which gallops about at such an extraordinary rate, expends all its food in the production of force,* and does not grow rapidly.

Perhaps the greatest refinement in fattening is exhibited in the manner of feeding ortolans. The ortolan is a small bird esteemed a great delicacy by Italians. It is the fat of this bird which is so delicious; but it has a peculiar habit of feeding, which is opposed to its rapid fattening—this is, that it feeds only at the rising of the sun. Yet this peculiarity has not proved an insurmountable obstacle to the Italian gourmands. The ortolans are placed in a warm chamber, perfectly dark, with only one aperture in the wall. Their food is scattered over the floor of the chamber. At a certain hour in the morning the keeper of the birds places a lantern in the orifice of the wall; the dim light thrown by the

* Dr. Drury, the physician to the private lunatic asylum in Glasgow, informed me that very violent patients eat an enormous quantity of food, and yet never become fat; while low lethargic patients (when they are not melancholic) have great tendency to become so. In the first case, the violent muscular exertions of the unhappy patients exhaust the food which they consume; in the latter case, it produces increase of size, from not being expended in the production of force.

lantern on the floor of the apartment induces the ortolans to believe that the sun is about to rise, and they greedily consume the food upon the floor. More food is now scattered over it, and the lantern is withdrawn. The ortolans, rather surprised at the shortness of the day, think it their duty to fall asleep, as night has spread his sable mantle round them. During sleep, little of the food being expended in the production of force, most of it goes to the formation of muscle and fat.* After they have been allowed to repose for one or two hours, in order to complete the digestion of the food taken, their keeper again exhibits the lantern through the aperture. The rising sun a second time illuminates the apartment, and the birds, awaking from their slumber, apply themselves voraciously to the food on the floor; after having discussed which, they are again enveloped in darkness. Thus the sun is made to shed its rising rays into the chamber four or five times every day, and as many nights follow its transitory beams. The ortolans thus treated become like little balls of fat in a few days. The process speaks much for the ingenuity of its inventor, if it does not for the intellect of the ortolan. In this refined mode of feeding, every condition for the fattening of an animal is united—*i. e.* warmth, plenty of food, want of exercise.

It is a question often asked, and one which I shall not presume to answer, whether cattle should be fed in stalls or in small yards with sheds attached. Certainly the former would appear at first sight to be the most preferable, because less motion is permitted. But it is also possible that, the health of the animal being impaired by this treatment, the energy of the vital principle may be so far subdued as to prevent a rapid increase of the body; while, the health being better in the latter case, and only a small amount of exercise permitted, the increased energy of the vital powers may more than compensate for the loss experienced by the motion of the animal. The flesh of the cattle in the yards must also be firmer and more fitted for the butcher, while the cattle tied to stakes will, in all probability, be possessed of more tallow. I have already discussed, in my former lecture, the conditions for producing tallow and flesh in an animal, and have at the same time pointed out the different kinds of food best adapted for each of these purposes. I do not, therefore, again refer to this subject, except to say that the condition of an animal, either as to tallow or to flesh, may be made to suit the wishes of its feeder, by attention to the chemical composition of its food.

The manure obtained from animals stall-fed must differ considerably from that dropped in the field. When exercise is

* Part is expended in restoring the tissues exhausted by the involuntary motions.

permitted, the urine of the animal is richer in nitrogen than that voided in the stall; for the nitrogenous matter of the tissues expended in the production of force is separated from the system in the form of urine. In the stall-fed animal there is comparatively little waste of matter, and hence the value of the urine, in its ammoniacal ingredients, is considerably diminished. As less food suffices for the sustenance of the animal in the stall, this, together with the diminished waste of its tissues, decreases the amount of manure, and renders it poorer in inorganic ingredients than that furnished by grazing animals. The opposite opinion is generally entertained. This arises from the circumstance that the manure from stall-fed animals is more efficacious, both from its better preservation and more profitable distribution over the land. Still this does not invalidate the conclusion, that the manure of an animal fed in the field is of more value in a chemical point of view than that of one fed in the stall upon the same food.

Yet it would be very absurd to use this as an objection to the introduction of stall-feeding, as, in such a case, the objector must be prepared to assert that the manure obtained from an animal is of more value than its flesh; for the increased value of the dung of a grazing animal arises from a waste of its muscular apparatus. When cattle are fed on artificial food, the composition of the manure depends upon the quantity of inorganic ingredients contained in the food consumed. Thus 100 lbs. of mangold-wurzel contain only 1 lb. of earthy matter, while the same quantity of linseed-cake contains 7 lbs. of the same ingredients. But as only a certain portion of the latter is necessary for the formation of the bones, the remainder is separated by, and enriches, the excrements. Hence it is that certain kinds of food produce more valuable manure than others.

III. We have now to consider one of the most important branches of feeding cattle, viz. for dairy purposes. Attention to scientific principles, in this department of feeding, is likely to lead to the most beneficial results.

Milk is one of the most important secretions of the body. It has already been stated that it consists of casein (cheese), butter, sugar-of-milk, and various earthy and alkaline salts. Potash is perfectly indispensable to its formation: indeed, this alkali seems to be the means by which the albumen in the body is rendered soluble, and consequently converted into casein. We know little or nothing of the nature of secretion: we only know that certain glands have the power of appropriating particular parts of the organism or of food, in order to produce fluids, which are either separated from the system, or perform some new functions in it. In the secretions the chemical forces play an important part, although the peculiar nature of their action is but imperfectly

understood. We know, for example, that the albumen contained in the serum of blood may be converted into casein by mixture with a little caustic potash (Scherer) : but we are entirely ignorant how the conversion is effected in the animal economy. Potash is quite indispensable to the formation of milk, and hence it is highly probable that the transformation of albumen into casein proceeds in the way already described : but it does so under the direction of vitality ; for we are aware that the composition of the secretion of milk or tears is influenced by nervous and mental affections, as well as by many other causes which tend to alter the state of the vital forces in the body.

It is a question of some interest, whether the amount of casein in milk is increased by the waste of the tissues of the body ? The milk of a cow in the meadow contains more casein than that of a stall-fed cow ; and I have found that the evening's milk generally contains more casein than milk obtained in the morning. In the first case, the cow in a meadow obtains exercise, and consequently the tissues of its body undergo a certain degree of waste ; while in the latter case a similar condition holds, for during the day a cow has more exercise than at night : still these cases might be explained on the supposition that the proportion of butter, sugar-of-milk, and water, in the milk, varied in the different states. But another strong proof of our view is drawn from the composition of the milk of a cow immediately after its parturition. During labour the muscles are thrown into a violent state of action, which occasions a proportionate waste of the tissues of the body : as parturition generally continues for several hours, the waste of matter in the body is very considerable. Now if this waste of the tissues actually increased the amount of casein in the milk, we should expect to find a notable increase of that body in the milk of a cow which has just calved : and this we know to be the case ; for such milk is quite thick with cheese. Boussingault found the composition of the milk of a cow, before the calf had been allowed to suck, as follows :—

Casein	.	.	15.0
Butter	.	.	2.6
Sugar	.	.	3.6
Ashes	.	.	0.3
Water	.	.	78.5

100.0

Here then we find that the milk contained 15 per cent. of casein, while the milk of the same cow usually contained only 3 per cent., or one-fifth the quantity. I am quite aware that there is some difficulty in conceiving a separation of part of the organism without a destruction of its chemical composition ; but,

in the present state of our knowledge, we cannot deny that a separation might take place by a simple alteration of the chemical nature of the components of the organism, without a change in composition: thus the alkalis liberated by the destruction of a tissue might possibly convert the albumen in the blood into casein, and thus the waste of the tissue would indirectly increase the amount of casein in the milk. The cases already cited might be explained on this supposition.* We have the more insisted upon this point, because by it may be explained several apparently anomalous circumstances in dairy-farming.

The second principle connected with milk which we ought to consider is the production of its butter. We have already stated our experiments (*Memoirs of the Chemical Society*, vol. i.) against the theory of Dumas, that the butter contained in the milk of a cow is solely derived from the fat in its food: this doubtless has a very considerable influence; but we conceive that the formation of fat from starch, as pointed out by Liebig, is too well supported by agricultural experience to be denied. In the opinion of the latter chemist, fat, and consequently butter, is produced by a separation of oxygen from the elements of starch. The butter, when once formed, is very easily consumed by the oxygen of the air.

Sugar-of-milk, or *lactine* as it is sometimes called, closely resembles starch in its chemical characters, and differs from it in composition only by containing more of the elements of water. According to Liebig (*Animal Chemistry*, p. 73), starch may be considered as composed of 12 atoms of carbon with 10 atoms of water, while sugar-of-milk may be viewed as starch, with 2 atoms of water in addition. Hence, in a chemical point of view, there is no difficulty in accounting for its formation.

We are now prepared to consider the practice of dairying.

In woman we find that anything which tends to annoy her, to irritate her feelings, or produce an exhibition of anger, occasions at the same time a partial destruction of the valuable constituents of her milk. We have it in our power to observe these effects in woman with more accuracy than in the lower animals, though doubtless similar feelings will produce in both the same change in the composition of the milk. The milk of a woman who has experienced a violent and sudden fit of anger is found to be quite

* It may be objected to this view, that, were the explanation now given correct, the milk obtained after calving should contain a large quantity of alkaline salts, while in reality the analysis of Boussingault gives an unusually small proportion. But we have shown in another paper that the method employed by Boussingault for estimating the ashes of milk is inaccurate; and that the ashes in milk are always much higher than exhibited in his analyses.

sour : hence it is requisite that wet-nurses should be kept in a state of perfect tranquillity both in mind and in body.*

For a similar reason it is necessary in dairy-farming to use every means to insure the tranquillity of our milch-cows. Harsh treatment exerts a very injurious action on the nature of the milk, both from mental and physical causes. Dairymen are well aware of the evil results which follow, if cows be harassed either by dogs or by harsh keepers.

The great cause which renders milk *poor*, that is, deprives it of its proper quantity of butter, is the respiration of too great an amount of oxygen. This gas combines so easily with butter, that it is of great importance to prevent an excess from entering the body. Now the number of respirations is increased, either by exercise, or by external cooling—hence more oxygen in these cases enters the system, and consumes a proportional quantity of the butter of the milk. You all know when a cow runs, on its way home to be milked, that the milk becomes hot, and is prone to sourness. The running increases the number of its respirations, and, consequently, the amount of oxygen which enters its system. This oxygen unites with the butter, or, in common language, burns it ; and the heat produced in the milk is the result of the combustion of the butter. The milk in such a case is also reduced in volume : this is partly owing to the evaporation of its water by means of the heat thus produced ; hence it is that such milk is much poorer than usual, and apt to enter into acidity ; hence also your practice of driving home to be milked only those cows which feed near home, while those at a distance from it are milked in the fields. The amount of oxygen inhaled being too considerable, when the animals are driven from a distance, the butter is partly consumed. To obviate an excessive respiration of oxygen, we find that all good dairymen permit their cows to walk home as leisurely as they themselves will do, and never allow their driver to accelerate their pace.

A singular system is frequently pursued, which may be explained on this principle. In hot weather in summer, the cows are fed in the stall during the day, and turned out to grass during the night. Cattle are apt to be annoyed by the flies and by the heat during the day. The former cause them to move about to avoid their attacks, and thus they respire a greater amount of oxygen. This oxygen consumes that part of the food which otherwise would have been transformed into butter ; but when let out at night, they are not thus disturbed, and the darkness

* The sympathetic irritation, which occasions a change in the nature of the secreted fluids, is conveyed through the sympathetic system of nerves, whose branches accompany the blood-vessels to every part of the body, and are furnished to the heart and viscera.

prevents their wandering about: thus they obtain exercise sufficient to furnish them with a good appetite, and the butter in the milk is not consumed. On the other hand, if the night proved cold, more injury than good would be experienced by this system, for a greater amount of butter would be destroyed. Stall-fed cows furnish the greatest proportion of butter, a fact to which we shall again advert. Any deficiency of heat must occasion a combustion of butter to supply the requisite quantity. On this account we select warm sheltered pastures for our cows, and do not expose them to sudden changes of temperature. When butter is the object desired by the dairyman, too rich pasture cannot be supplied to his cows.

The production of cheese in the milk involves certain other conditions. I have travelled through the principal cheese districts to acquire information on this point, but the evidence furnished by cheese-dairymen is very conflicting, and apparently contradictory. Almost all cheese districts agree in asserting that *poor* land is best adapted for cheese, though there are certain other districts in which the very reverse is affirmed. This arises from the quality of cheese manufactured: those dairies which depend equally upon their butter and cheese, and prepare the latter principally from skimmed milk, must possess rich pastures fitted principally for butter; but in dairies such as those of Somersetshire or Cheshire, in which butter is of a secondary consideration, their pastures are in reality not so rich. In Gloucestershire and Somersetshire I found the opinion prevalent that *poor* land produced the *best* (greatest amount of?) cheese; and in the third volume of 'Young's Six Months' Tour' it is stated, 'in Cheshire they find that the inferior sorts of pasture lands are the best suited for cheese.'

In *poor* lands the cows have more ground to traverse in order to obtain a sufficiency of food, and consequently the oxygen respired by the increased exercise compels them to eat a greater quantity. By this increased quantity more cheese (casein) is furnished to the milk. Land is considered rich, not when its grass abounds in albumen, but when it contains the constituents of food fitted for the production of fat. And, if my opinion formerly expressed be correct, viz., that the waste of the tissues increases indirectly the amount of casein in the milk, then another reason is given why *poor* land should be better adapted for the growth of cheese than that which is rich.

Rich grass (*i. e.* grass which contains a large proportion of carbon) is more fitted to sustain the animal heat of the body than grass of a poorer nature—consequently less of it is necessary for this purpose, or, in the language of agriculturists, its *equivalent* is higher. The equivalent of *poor* grass being lower, a greater

quantity of it is consumed by the animal for the support of the heat of its body, and hence the casein (cheese) in the milk is increased. To induce the cows to eat a *large quantity* of food (an indispensable condition, as the casein is in small proportion in grass), we find in large cheese-farms that they are driven to a fresh pasture every day. Very little cheese is produced from the milk of stall-fed cows, on account of the small quantity of food consumed in the stall and consequent diminution in the amount of casein. But the pastures fitted for the production of cheese should not be, strictly speaking, poor; Stilton, Cheddar, and Cheshire cheeses contain a very large amount of butter—consequently the milk of the animal must contain a considerable quantity of this ingredient. In some parts of Somersetshire the cows are put into rich and poor pastures alternately after each milking.* This ensures the requisite quantity of butter, as well as of casein.

The different flavours of the cheeses of various districts depends more upon the difference on the chemical state of the rennet with which it is prepared than in the herbage upon which the cows feed; still there is no doubt that particular plants impart a peculiar flavour to the milk. You are well aware that swedes possess this property. Newman, as far back as the commencement of the last century, observed that milk is rendered yellow by taking saffron, bitter by wormwood, and odorous by garlic.†

The greatest care must therefore be taken in removing from the pasture those plants which may prove injurious to the cows feeding upon them. To give an example of the necessity for precaution, I may cite an instance which fell under my own observation. A few months since Professor Liebig, Dr. Buckland, Dr. Daubeny, and myself were examining the pastures of a celebrated cheese-farm in Somersetshire. The proprietor of the farm took us to a field, the *grass* of which he affirmed *scoured* the cattle so much that it was unfit for pasture. Being well aware that this was not due to the grass, we began to examine the cause, and Dr. Daubeny found that purging flax (*linum catharticum*) grew luxuriantly over the whole field. This plant is quite noted for its purgative action, and at once explained the mystery. The next pasture to which we were taken had quite the opposite character; and the cattle, after feeding on the first, used to resort to the second to correct the purgative effects received by this noxious plant. In this new pasture we found the common tormentil or septfoil (*potentilla tormentilla*) abounding, a plant equally well known for its astringent qualities. Attention to the

* Information furnished by Mr. Norris, near Bridgewater.

† *Chymia Medica, dogmatico-experimentalis.*

eradication of these two weeds would have at once restored the pastures to their proper condition.

In London, Edinburgh, and Glasgow the system of stall-feeding cows is extensively practised. As I have never visited the London establishments, I shall confine myself in my description to the Scotch method, though I presume both are nearly the same. It is usual to allow the cows to pasture during the summer months, when the weather is propitious. Although the exercise thus received tends to diminish the quantity of butter in the milk, a greater flow of milk is really obtained, as their digestive apparatus is kept in a healthy state, and their appetite consequently increased. When kept in stalls they are fed upon grains, and allowed daily a few pounds of bean-meal. All the Scotch dairymen assured me that beans formed the most valuable food which they could give to stall-fed cows. The cows are permitted to drink as much *pot ale* (ale refuse) as they wish. Steamed turnips and potatoes are used as valuable additions to the preceding food.

Now let us consider the theory of this method. Malt refuse contains starch, saccharine matter, a kind of mucilage, and a small quantity of albumen. The greatest part of the nitrogenous constituents have been removed; hence the grains do not contain substances fitted for an abundant supply of casein, but for the formation of butter and sugar of milk they are admirably adapted. The beans furnished to the cattle contain casein ready formed, and therefore supply the deficiency in the previous food, while their starch and oil assist in the formation of the sugar of milk and butter. The *pot ale* serves to increase the flow of the milk. Pure water does not readily enter the blood. We know that it destroys the blood-globules: but acidulous water does not do so, and this *pot ale* is acid; it therefore enters the blood, and increases the flow of milk by diluting the secretions. It contains also alcohol, sugar, and starch, by means of which the respiration may be partly sustained, and the other food economised for the production of butter. The stalls in which the cows are kept are warm, and not too much exposed to light. The former economises food; and the latter condition does so likewise, by lulling the animals to repose.

I have made a series of experiments in connexion with this lecture, in order to show the influence of food and exercise upon the secretion and composition of the milk of a cow. The cow was fed in the meadow and its milk analysed, and afterwards brought into the stall, its milk being in like manner subjected to analysis. The difference in composition was very marked; the milk obtained in the meadow contained more casein and less butter, to the amount of several per cent., than that taken from the same

animal stall-fed. I then fed the animal upon various kinds of food, such as hay, potatoes, oatmeal, beans, &c., mixing these in determinate weights, and analysed the milk of the cow fed upon such food.

The details of the experiments are too numerous to bring before you on the present occasion, and I shall therefore publish them in a separate paper. I may merely state at present that the difference in composition was most marked, and fully bore out the manner of estimating the value of food, as given in the preceding tables. Beans were found to increase the quantity of cheese in the milk, as theory would lead us to expect, while steamed potatoes caused an abundant increase of the butter.

IV. Before concluding the subject of feeding cattle, might I be permitted to say a few words with reference to certain of their diseases, though this does not come within the subject assigned to me by the Council of the Society. When we consider the most important diseases of sheep, such as rot, foot-rot, black-water, consumption, diarrhœa, and dysentery, we find that they possess, in a chemical point of view, a generic character. They are diseases which effect a transformation or decay of particular parts of the body.

When a fresh orange is placed upon a decayed one, the decay in the latter is communicated to the former, and the fresh orange becomes tainted. In like manner a piece of decayed wood occasions the decay of a piece of sound wood placed in its vicinity. There are numerous chemical instances of the same fact;* and indeed it appears to be a law pretty well established, that every body in a state of change has a disposition to throw any other body with which it comes in contact into the same state with itself. Now (we speak only in a *chemical* point of view) consumption, diarrhœa, and dysentery may be classed together, as being in the same category of diseases. The first is an inflammation of the lungs; the two last, of the intestines. *Inflammation*, in a chemical sense, is the proper term; for the true definition of the term is, a combustion, or union with the oxygen of a part of the tissues, or of the secretions of those tissues. That the final cause of consumption merely consists in an oxygenation or combustion of the substance of the lungs, instead of the blood circulating within them, is proved by many circumstances. First, in consumption, the lungs disappear or are consumed, along with other parts of the body, which participate in the combustion. Thus the milk of a consumptive cow contains very little butter. D'Arboval† assures us that the cows fed on the mountain pastures of Switzer-

* See the 2nd Part of Liebig's Agricultural Chemistry.

† Youatt on Cattle, p. 413.

land never take consumption. Mountain air is very much expanded, and consequently little oxygen enters the lungs at each respiration: hence it is all taken up by the blood, and does not act on the substance of the lungs.* But D'Arboval, in continuation, informs us that those cottars who have no upland pastures, but keep their cattle shut up in miserable unventilated huts, lose many of them by this disease. This is another proof of our view.

The exhalations from the cattle fill the hut, and enter into a state of decay; or, to speak chemically, enter into union with the oxygen of the air. This decay or union is imparted to the lungs of the animals within its influence, and consumption results. And, in confirmation of this latter explanation, I refer you to Mr. Youatt,† who states that, in crowded cow-houses, those animals escape consumption which stand near the draughts of the doors and windows, and therefore have the deleterious exhalations carried off; while those protected from the draughts often droop and die:‡ *à priori*, the very reverse would be expected.

I said that diarrhoea also consisted of a union of oxygen with part of the intestines, and this disease generally accompanies con-

* As a contrast to this I may mention a striking case which lately came under my own observation. In July last there were four days in which the barometer was unusually high (*i. e.* the air very condensed); during those four days there were no less than five deaths of consumptive patients in the small town in which I reside.

† Youatt on Cattle, p. 414.

‡ Professor Sewell, in his 'Essay on the late Epidemic amongst Cattle,' has the following passage:—"However, a predisposition to receive the disease may, and I believe is, caused by the vitiated atmosphere in the stable or vicinity—arising from foul, damp, or unaired stables; stagnant cesspools, obstructed drains, or a want of drainage; the vicinity of dung-pits or heaps; stagnant water in ponds, ditches, and shallow streams which receive the contents of drains or of sewers; irregular pavement, retaining the excrements, by which the floor is saturated." Now all these are cases to impart a pre-existing decay, or union with oxygen, to some part of the system. But all our experience of the diseases of cattle serves to support this chemical explanation of their origin. In cold weather, when the air is much condensed, and therefore when a large quantity of oxygen is ready to act upon the system, we find that acute inflammatory complaints are most common—*i. e.* complaints arising from an excess of oxygen. On the other hand, when the temperature is elevated, and therefore when the oxygen enters the system in less quantity, biliary complaints are most prevalent. "Biliary diseases arise from an excess of carbon," which the oxygen inspired does not suffice to consume (Liebig). In the Royal Veterinary College every precaution is taken to prevent the sick cattle from being exposed to an impure atmosphere. The consumptive patients are kept in sheds in the open air, in order that the decaying exhalations may be rapidly carried off, and none allowed to accumulate near them, lest their state of union with oxygen might be imparted to the system, and aggravate the malady. This, however, may be an explanation of their practice, which the professors of the College may not be willing to admit.

sumption in cattle. The combustion of food, by which animal heat is supported, takes place in the intestines, and not in the lungs, as is usually supposed. The intestines are, therefore, very liable to inflammation (union with oxygen). When cattle are protected from cold, and therefore not under conditions to be affected in their lungs, the decay (union with oxygen) of the putrid exhalations is imparted to the intestines, and, according to its intensity, produces either diarrhœa or dysentery. Mr. Pusey informed me recently that he knew several cases in which diarrhœa had broken out amongst sheep shedded according to Mr. Childers's plan. I should ascribe it, in all these cases, to an imperfect ventilation of the sheds, or perhaps to decayed food. Consider the various causes of diarrhœa and dysentery, and you will agree with me as to the explanation. Low and marshy grounds, flooded fields, bad water, over-work, the neighbourhood of stagnant ponds, the continuation of sultry weather,—all are causes which contribute to produce dysentery in our cattle; all are causes also either to impart a pre-existing state of decay (union with oxygen) to the intestines, or to introduce a more than usual supply of that gas to the system.*

The first class of diseases now mentioned is not infectious, because putrid exhalations do not form their necessary consequence. Dysentery in cattle is indeed contagious, but this arises only when much decay proceeds in the body, as indicated by the putrid smell of the excrements.

The second series, such as rot, is, on the contrary, highly contagious. A rot, perfectly resembling that of sheep, occurs in the human race, when decayed sausages or other putrescent matter is consumed. The unhappy patient becomes rapidly emaciated, the fluids in his body disappear, he dries to a complete mummy, and finally dies. On a *post-mortem* examination it is found that his liver and abdominal viscera have participated in the decay. This is a true case of rot in man, arising from decay *communicated by his food*, and perfectly analogous to the rot in sheep. Both arise from the same cause—*i. e.* by the communication of a decay previously existing in some other body. Mr. Cleeve, in his excellent 'Essay on the Diseases of Sheep,'† states "that May and June are the months in which the contagion is generally found to exist; and then exactly in proportion to the prevalence of heat after showery weather;" or, in other words, exactly when decay of animal and vegetable matter is at its maximum. The rot in sheep produces decayed exhalations, which, if brought into con-

* The unpleasant diseases called red-water and black-water also seem to proceed from similar causes; and arise when the kidneys, instead of the intestines, become the seat of the attack of oxygen.

† Journal, vol. i. p. 313.

tact with other sheep, will produce the same disease in them. Mr. Rusbridger, the Duke of Richmond's agent in Sussex, states that foot-rot is communicated to sheep when they tramp upon any of the acrid matter left upon the ground by a diseased sheep.*

These few considerations regarding the nature of the most common diseases in cattle may induce you to employ proper preventive measures. As to curative agents, I am not a practitioner, and with these dare not interfere. It is only worthy of remark, that antiputrescent substances must act favourably. Thus, salt is a favourite remedy; and it is a fact well known, that rot never occurs in salt marshes. Whether practitioners might not advantageously use other antiseptic substances, such as the empyreumatic bodies, is a thing for them, not for me to determine.

We have now, in this and in the preceding lecture, considered, in a very imperfect manner, the principal subjects connected with feeding cattle. But there is still a very important topic to discuss,—viz. the recognised signs of fattening and of early maturity. I shall endeavour to offer a few remarks on this point.

V. On considering this subject, it will be found that few data exist to enable us to arrive at accurate conclusions concerning the signs of early maturity. This arises from the little attention which has been paid to the anatomical structure of the organs of cattle of various breeds. The external signs enable the farmer to arrive at approximate conclusions regarding the aptitude of an animal to fatten. It was the duty of the comparative anatomist to avail himself of the farmer's knowledge, and describe to us the appearance of the internal organs of animals possessing this aptitude. As far as I am aware, this has not been done. As our data are insufficient, we must be cautious in giving credence to the opinions expressed by any individual on such points, until his views receive more extended confirmation than they can at present do. With this preliminary caution regarding the views which I now submit to you, I may venture to make a few remarks, less with the intention of insisting upon the correctness of my opinions, than to incite you to make observations upon the subject, and either confirm or refute them.

Let us first commence with the internal structure of the animal; for the external form is only an indication of the action of the organs within.

The considerations on the theory of fattening which have now been brought before you naturally lead to an inference in total opposition to all opinions at present entertained, and—you will, perhaps, think—in opposition to your own experience. Did I

* Journal, vol. i. p. 319.

believe that it was in reality opposed to your experience, I would at once discard it; but the apparent contradiction appears to me to be a misconception. The view I allude to is the following: that the peculiar aptitude of any animal, or of a breed, to fatten, must arise from a peculiar *smallness* and fineness of texture of the lungs. Although Liebig has not announced in his work the opinion that smallness of lungs is an indication of a tendency to become fat, still he conceives that it is so. On consulting some eminent physiologists in our own country, I find that they also entertain the same view. Cline asserts quite the contrary, and agriculturists have generally acceded to his opinion. He says,* "An animal with large lungs is capable of converting a given quantity of food into more nourishment, and therefore has a greater aptitude to fatten." Mr. Youatt holds a similar doctrine; and both he and Mr. Cline uphold their opinion by reference to the capacity of the chest. "On the roundness and capacity of the chest," says Mr. Youatt, "depend the *size* and the power of the important organs which it contains, the heart and the lungs; and in proportion to their size is the power of converting food into nourishment." The opinions of two such authorities deserve every attention; and yet theory compels us to hold a different view. Let us therefore examine their reasons more closely.

In the first place, it does not necessarily follow that large lungs should be placed in a round and capacious chest. The chest and lungs are independent formations; the one may exist, while the other does not exist, or has almost disappeared. Secondly, the chest in cattle often contains a portion of the abdominal viscera, the diaphragm being pushed forwards. Thirdly, a capacity of chest may indicate a rapidity of respiratory action, with a small lung. But we will give two more quotations from Mr. Youatt's own works to show this:—"The slightest inspection of a well-formed sheep will show that the ribs spring from the spine more horizontally than those of the *horse*, or even of the *ox*; and consequently the greater roundness and capacity of the chest."† And, again, farther on, in the same work, Mr. Youatt states:—"In the horse the lungs are necessarily capacious. In the ox the lungs are less developed. In sheep little exertion of strength or speed is required, and the lungs are smaller, compared with the size of the animal."‡ We therefore see by Mr. Youatt's own description that the size of the lungs in these animals is *inversely* proportional to the roundness and capacity of the chest. The ribs of a pig spring more horizontally out from the spine, and the chest is consequently rounder than that of any of the other

* On the Breeding and Form of Animals, p. 4.

† Youatt on Sheep, p. 420, *ubi supra*.

‡ *Ib.*, vol. ii. p. 443.

animals mentioned by Mr. Youatt. Now the pig has also smaller lungs. The order of smallness of lungs is therefore as follows:—pig, sheep, ox, and horse: *and the order of their aptitude to fatten is the same.* For this last forcible remark I am indebted to Earl Spencer. Now, let us take two well-marked breeds, and compare them. The Leicester breed of sheep have round, broad, and capacious chests; while the South Downs have, comparatively speaking, narrow shoulders and breasts. But an inspection at the butcher's shop shows that the lungs of the Leicester breed are small, firm, and compact in their texture; while the lungs of South Downs are larger and coarser. My attention to these two breeds was directed by Mr. Morton; and I have since found that butchers generally affirm the same fact with respect to the different size of their lungs. Here is another example that broad chests do not necessarily indicate large lungs: the very habits of these breeds show this. The Leicester sheep cannot inflate its lungs like the South Down, and soon pants for want of breath. Through the kindness of Earl Ducie there is now in progress an extensive series of experiments, in which the lungs, heart, and liver of animals of the same and of different breeds are weighed, and compared with the weight and appearance of the carcase. The result of these will either confirm the truth or prove the inaccuracy of this view.

I have visited very many butchers, and, without any explanation, put to them this simple question, "Are the lights and liver of very fat cattle large or small?" and the uniform answer was, "Very fat cattle have always *small* lights and small livers."

I trust these statements will induce you to follow me in this view, without prejudice because the doctrine is new.

Every farmer is aware that certain breeds of animals have a more early maturity than others. The short-horned cattle acquire a greater weight, with a far less consumption of food, than the long-horns. I must beg not to be misunderstood in my remarks upon the various breeds. Not being practically acquainted with them, I have always followed the best authorities who honoured me by furnishing the results of their experience. But on a subject in which all our enthusiasm, and sometimes our prejudices, are enlisted, I may be so unfortunate as to give offence, even when I suppose myself on firm ground. The opinion of one who has but lately turned his attention to this subject is not likely to be a *causa belli*; but to avoid it, I beg distinctly to state that I do not in my allusions refer to any particular breed as at present existing, but to the aboriginal breeds, the merits of which are a matter of history. The Chinese pig acquires fat more quickly than the Irish. The farmer knows further that there are great differences in the aptitude to fatten even in animals of the same

breed. All these differences must be due to some cause. I have already fully explained to you that the disappearance of food from the system is owing to a combustion of the food by means of the air inspired by the lungs. The oxygen which has once entered the system never again escapes from it without being united either with part of the body or of the food.

Now, suppose that we were feeding two pigs with precisely the same size of lungs, the same quantity of air is taken into their body at each respiration. If they received the same quantity of food, they must increase equally in size, because the same amount is expended by the air respired, and the remainder, being equal, must be assimilated. But let us give to one pig double the quantity of food that the other receives; then, the air being only able to consume the same amount of food as before, the pig must increase twice as rapidly as the other. This is quite obvious. Again, suppose the pigs to have different sizes of lungs,—let us take the Berkshire and Neapolitan pigs, for example, and suppose the former to have larger lungs than the latter—let us assume in the proportion of two to one;—if we give each of the pigs 30 lbs. of potatoes daily, the Neapolitan pig will, on the same quantity of food, increase twice as rapidly as the Berkshire, because, by our assumption, its lungs are only one half the size. This, in other words, means, that as only one half the quantity of oxygen enters its body at each respiration, this quantity can only consume half as much as the double quantity of air does in the Berkshire pig. That which is left in the body unconsumed must increase its size. A little consideration will show that the case cannot be otherwise.

Now, to take a case without an assumption. The Leicester sheep have smaller lungs than the South Downs. In an experiment at Whitfield Example Farm it was found that a certain number of Leicesters, during a given time, reached 28 lbs. a quarter; while South Downs, with a greater consumption of food, reached in the same period only 18 lbs. a quarter.* As much more oxygen entered the bodies of the South Downs, a greater quantity of food was necessary to unite with it, and consequently their increase was slower. When an animal feeds slowly, or, in other words, when it possesses large lungs, we try to give it a greater aptitude to fatten, by crossing it with a breed which possesses small lungs. Thus the Chinese pig we know to have small lungs, while those of the Irish pig are large. But a cross between these feeds more quickly than the Irish alone, because the Chinese pig has imparted to it its smallness of lungs. We know that the character of the lungs is generally handed down from parent to child. The hereditary tendency to consumption exhibited by

* Information furnished by the Earl of Ducie.

the progeny of consumptive parents arises from an imparted delicacy of the lungs.

Now, should further confirmation of these views be obtained—and I have little doubt that they will—it would be very valuable to obtain a series of averages, representing the size and weight of the lungs of different breeds of cattle; for thus we should be furnished with a rational guide to enable us to discover the manner in which we can best convey to a breed an aptitude to fatten.

Donaldson asserts that the properties of a milch-cow and of a cow disposed to fatten are quite incompatible. This must be entirely a mistake. The very circumstance of a cow yielding much butter in her milk shows that her food is readily converted into fat. She would not be a good milch-cow if she fattened at the same time that milk was secreted. But when the milk has ceased to flow, then she must have an aptitude to fatten rapidly. Small lungs must be particularly favourable to a milch-cow. In fact the breed of short-horns shows that practice proves what theory indicates; for they both fatten well, and are good milch-cows. They may not secrete so much milk as certain other breeds; but if our view of the smallness of their lungs be correct, their milk must be rich in butter.

Several practical farmers, to whose judgment and experience I would pay the highest deference, inform me that I am decidedly wrong on this point. In defence I quote the Rev. H. Berry's opinion:—"The excessive quantities of milk obtained from the unimproved short-horns are seldom or ever obtained from the improved; but a moderately good milker of the latter kind will be found to yield as much *butter* in the milk as one of the former; the milk being unquestionably of very superior quality." (Youatt on Cattle, page 239.) Theoretically I cannot discover why the two qualities should be incompatible. That they often are so, I admit; but by attention to the habits of the animal, I think they might be harmonized.

It must be observed that the fact of an animal possessing large lungs will not prevent a strong development of muscle, but may, on the contrary, tend to this. But the flesh in this case will be coarse, liery, and destitute of fat, as we observe in the unimproved breeds. It is upon the unazotized portion of the food, or upon that which forms fat, that the oxygen inspired by the lungs principally acts. The large amount of air respired by the large lungs consumes this food, but does not so quickly attack the azotized portions. Such animals may therefore have coarse flesh, and consequently large intestines. And we know, in fact, that the offal of these slow feeders is greater than that of the kindly ones.

All this may appear very chimerical to many of you, and further information may possibly overturn this opinion; but until it does

so, I contend that theory is completely on my side, and I trust practical men will not refuse me their aid in putting it to the test of practice.

The liver is the next organ to which I would attach peculiar importance in the aptitude of an animal to fatten. The bile is a fluid secreted by this organ. I have explained to you in my last lecture, that the bile is destined for supporting the heat of the animal body. Liebig considers that bile may be produced by the liver itself from unazotized food received directly from the intestinal canal, together with azotized substances derived from the blood. An ox secretes about 37 lbs. of fresh bile every day, which is equivalent to 59 oz. of dry bile, the rest being water. In the normal state in which an animal is placed, little of this bile passes out along with the excrements, for the greatest part is taken into the blood, and its unazotized part consumed in the support of respiration and consequent heat of the animal; while the kidneys separate in the urine the parts containing nitrogen. But if there be more bile formed than the air suffices to consume, the excess is separated by means of the excrements. Tallow (fat) is probably produced from the excess of food which the liver has been unable to form into bile. Now suppose that we put up an ox which possesses a large, *sound*, and active liver, to be fed in the stall—we decrease the number of its respirations, and consequently the amount of oxygen which enters the body. Less bile, in this case, will be consumed; but as it is still formed as before, though not quite so rapidly, a greater proportion will now pass out with the excrements. Let us suppose that the liver of this animal secretes 37 lbs. of bile daily—37 lbs. of bile contain about 40 oz. of carbon—and that the amount of food given to it is 60 lbs. of mangold-wurzel. Let us have in the same place another ox, receiving exactly the same quantity of food, but whose liver, being smaller, only secretes 30 lbs. of bile daily. Now as bile is formed principally from substances which, if not so employed, would produce tallow and also a certain quantity of flesh, the latter on secreting 30 lbs. of bile daily must fatten more rapidly on the same food than the former ox, from whose liver 37 lbs. of bile are secreted; because having 7 lbs. of bile less to form, all the food necessary for producing this must become tallow. An animal with a small liver will also produce more flesh (muscle) than an animal with a large sound liver, which produces much bile. Nitrogen is an essential constituent of the bile. The bile of animals permitted to roam in their natural state, receives this element from the transformed tissues of the body. It is known that albumen suffers no change in passing through the liver and kidneys, and hence the nitrogen of the bile must be received from the transformed tissues: but if the bile did not require this nitrogen, it

would remain untransformed in the form of flesh. The nitrogenized substances of the bile are unfit for the nutrition of the animal, and are consequently separated from the blood by the kidneys. From this it is obvious that an animal with a small liver will increase more rapidly in flesh as well as in tallow, because less of the nitrogenous part of its food is required for the formation of the bile.

All this is not fanciful doctrine, as you may at first suppose. Thus I told you in my last lecture, that we could not fatten a goose when salt was given to it in quantity sufficient to form bile, although not to purge. This goose was crammed several times a day, and yet it did not fatten, because most of the food was formed into bile and passed out with the excrements.

You may have heard that Mr. Bakewell used to bring his sheep to the market some time before other feeders. This he effected by producing rot. In the early stages of rot sheep acquire both fat and flesh with wonderful rapidity.* This probably arises from the liver being unable to produce the proper quantity of bile. In certain diseases arising from inflammation of the liver, both this organ and the blood become loaded with fat. The food, which otherwise would have formed bile, now produces fat and flesh. In making any observations on this point to ascertain whether or not my opinion be correct, you must always discriminate between sound livers and those which become enlarged by disease or by the insertion of fat between its cells.

From the remarks which I have now ventured to make, you will perceive that I consider the aptitude of an animal to fatten to be due to the size of its lungs and of its liver. Of course the size and proper play of the heart must also have great influence, but this in a less direct way, and more from the general constitution of the animal being determined by it. The size of the intestines will also be proportional to the magnitude of the other organs.

There are certain external signs which enable us to determine whether or not an animal possesses an aptitude to fatten. Amongst these, smallness of the bones seems to be one of the most generally recognised.

Smallness of bone is generally the indication of delicacy of constitution. An animal with large bones to support the weight of its body is active, like the Irish pig, and apt to become restless in its habits. Activity and lethargy have much connexion with the quantity of oxygen taken into the system. The inhabitants of cold countries are very active and fond of laborious employment; those of warm countries are, on the contrary, lethargic. In the

* Youatt on Sheep, p. 446.

first case, the air being condensed, more oxygen enters the system, and incites the animal to exercise in order to carry off the transformed tissues of the body: but in warm climates little oxygen is respired, and the transformations proceed with so much slowness, that no such inducement exists with the natives. We have mentioned a case of unnatural diet in warm countries, which impels the foreigner to take exercise. Now we find large bones principally in restless wandering tribes of animals inured to much fatigue: their habits show that they possess large lungs. Such animals do not soon pant and lose breath by being driven, as the Leicester sheep do. The smallness of the bones is valuable as indicating the nature of the animal, its lethargic habits, and we might venture to add, although we want direct proof of this, its smallness of lungs. But there is another great advantage which small-boned animals have over those which possess much bone. The osseous or bony system possesses a great degree of vitality. We know that if the bone of a young animal be broken, the injury is quickly repaired by the numerous blood-vessels which ramify so extensively through the substance of the bone: but when the osseous system is less developed, less vitality is necessary to rear its fabric, and, consequently, more is left for the assimilation of muscle and of flesh. Small-boned animals must possess more *vegetative* life than those with large bones; for, being less active in their habits,* only a small amount of vitality (the cause of increase) is required to execute the commands of volition, and hence it is employed in increasing the mass of the body: this fact alone is amply sufficient to account for the preference given to small-boned animals. For the same reason we love to see an animal possess a placid countenance and a bright quiet eye. Farmers are unwittingly great believers in physiognomy, and judge of the temper of the animal by the appearance of its eyes and face. A quiet contented animal feeds and assimilates its food, as if it quite coincided in the propriety of its owner's wish, that it should rapidly make itself ready for the butcher; but a restless ill-tempered beast moves about and wastes its tissues in the production of force, throwing every obstacle in the way of its feeder's intention.

Another point very much insisted upon by the feeder is, that the animal should have a *mellow* feel. This 'mellowness' is a kind of softness and elasticity perceived upon pressing the skin, and is considered a favourable sign of the aptitude of an animal to fatten. Fat consists of little vesicles lodged within a modification of cellular tissue, to which the name of *adipose* tissue has been given; but it is in fact cellular tissue.

* The horse would be an exception to this rule.

consists of elastic fibres, and is distributed through every part of the body, so completely indeed, that could we conceive that all the remaining parts of the body were removed except this, a complete model of it would be left by the cellular tissue. The resiliency of the skin, or mellowness, as it is termed by farmers, is due to the proper condition and amount of the cellular tissue. In the healthy state of an animal, the interstices of the cellular tissue are filled with a fluid secreted from the blood. Hence, on pressing the skin, this fluid is pressed out of these interstices into the adjacent ones, which by their elasticity immediately return it on the removal of the pressure. But when an animal is not in a thriving state, the fibres of the cellular tissue lose their elasticity, and the skin *pits* on pressure. The resiliency of the skin, therefore, indicates the state and amount of the cellular tissue. Without an abundance of this tissue a sufficiency of fat cannot be formed, and hence we find farmers examining the resiliency or mellowness of the skin in those parts where fat is most desired. This, then, is to ascertain whether the *receptacles* for fat exist, and if they do, the farmer may be pretty confident that they will become filled when he proceeds to fatten the animal.*

It would be very interesting to ascertain why certain breeds of cattle have a disposition to secrete fat internally and others externally; but as I have not hitherto had any opportunity of studying this subject in connexion with the habits of the breeds, I shall refrain from making any observations upon it.

It is a common remark amongst farmers, that the "last food pays best," meaning, I presume, that during the latter stage of fattening the animal increases in weight more rapidly with less consumption of food. This would seem to arise from several causes. First, the deposition of fatty matter in the cellular tissues

* Cellular tissue consists of gelatin. Gelatin is a nitrogenized body different in composition from albumen and the other nitrogenized ingredients of food. Gelatin, when taken as food, does not seem to aid in the formation of flesh, but acts upon the cellular and other gelatinous tissues. Oriental ladies, who think fat a great beauty, acquire *embonpoint* by taking soups and food containing little nitrogen. The soups contain gelatin, and form cellular or adipose tissue, the receptacles for fat. The soups evidently act by producing what farmers call *mellowness*. In our country we do not think it necessary to produce this state in our ladies, and we might, therefore, try whether we could not do it with our cattle. If we were to treat them to soups made from the heels of cows or calves, or, more economically, by boiling bones in water for a considerable time, we would furnish the materials necessary for producing cellular tissue, or *mellowness*. The boiled bones might then be used as manure, so that no loss would be experienced. In certain diseases of cellular tissue in man, we must prohibit soups. This obviously shows that they act upon this tissue. It is true that the suggestion here made is quite theoretical, and, as far as I am aware, has not been tried. Is it not worthy of a trial in practice?

between the muscle and skin, and throughout the muscle itself, prevents the absorption of air by the skin, which we know actually takes place in the ordinary state of health. The oxygen of the absorbed air unites with part of the body or of the food; but after an animal is fattened to a certain amount, this absorption being prevented, a cause of waste is thus removed. Secondly, the deposition of fat in the liver and kidneys prevents their active action, and the animal is thrown into that diseased state which we desire, in which fat is formed at the expense of the formation of the bile. Thirdly, the most important cause, however, seems to be, that an unnatural quantity of fat is accumulated in the caul and loins. This fat pushes up or forward the diaphragm, lodges about the heart and edges of the lungs, encroaching much upon the space which should be occupied by the latter. The lungs are thus pushed aside and contracted, and consequently less air enters the body to consume the food. All these circumstances serve to render the greatest return from the food given in the last stages of fattening.

A farmer dislikes to see large ears, and experience has taught him that an animal possessing such ears will not prove a kindly feeder. It is needless to say that the shape of the ear or its delicacy cannot of itself be the cause of early maturity. The character of the ear can only be valuable as being the index of the operations of the internal organs. If an animal be prone to coarseness of flesh, that is, to a strong development of muscle, without much cellular tissue or fat, this will be exhibited by an increased size of ear. The old Kentish sheep, before it was improved by a cross with the Leicester breed, possessed large ungainly ears, coarse flesh, little fat, and large bones. But the improved breed, with a greater aptitude to lay on fat quickly, along with the flesh has thrown off its huge ears, and substituted in their stead much smaller ones. The Leicester sheep themselves, before Bakewell began to improve them, possessed large ears, and along with them coarse flesh, large bones, and little aptitude to fatten. In fact, a consideration of all the improved breeds shows us that the ears became smaller when the bones did also, and when the general coarseness of the animal yielded to the more delicate constitution of the quick feeders. What holds with respect to the breeds themselves, must do so with the individuals which constitute those breeds. Hence it is that largeness of ears becomes an index of the coarseness of the animal, and of the size of those organs which, we have endeavoured to show, produce this coarseness and prevent quick feeding.

It is universally admitted that a wide and capacious chest should be possessed by a good animal. This has much connexion with the development of flesh, for much valuable muscle

lies in front. When we examine a horse, we find the whole cavity of the chest filled by the lungs; but in the fattened domestic ox they only fill a part of it, the rest being occupied by the fat accumulated around the organs, and by the protrusion of the abdominal viscera. But enough has been said on this subject when treating of the size of the lungs.

There are certain cases in which animals exhibit an aptitude to fatten, although their chests are large and their cavity filled by large lungs. Thus the horse or the prize-fighter possesses large lungs. But both, when in training or working, have much exercise, and their lungs are kept in a constant state of activity. The amount of exercise which they receive increases the vital forces, and consequent assimilative powers of the system; but when they are deprived of exercise their lungs become contracted, and less air enters the system. But their digestive apparatus has become accustomed to much food, and their powers of assimilation are still strong: they, therefore, eat a large quantity of food, and, as little of it is now expended in force, they rapidly become fat. Such cases are, however, no objection to the general principles which we have advanced.

We have now examined some, far from all, of the applications of physiology to the feeding of cattle. We have had to contend with difficulties, both from a deficiency of scientific data on which to ground our conclusions, and from an imperfect knowledge of the practical part of our subject. I have honestly informed you of both of these obstacles to the establishment of our views, and it is therefore for you to determine which will or will not bear the test of a more thorough acquaintance with practice. You are also put in possession of the proper value to be attached to the theories brought forward; for I have requested you to look upon some of them with caution, as the mere opinions of an individual, and not as established truths of science. The subject is full of interest, and strange though it be, it has never hitherto been examined in its scientific relations. I sincerely trust that some eminent men of science will turn their attention to its elucidation.

The only credit which I attach to myself, in having introduced this subject to your notice, is this—that during the few weeks since I was honoured by the commands of the Council to appear before you (and as a soldier of this Society I thought it my duty to obey those commands), I have worked hard in your behalf; and though my labours may have proved unproductive, my intention to serve you has been good—a circumstance which, permit me to hope, will induce you to look with some degree of leniency on the very many faults contained in my lectures.

MISCELLANEOUS COMMUNICATIONS AND NOTICES.

I.—*On the Prevention of Blight on Apples.*

By JAMES ELLIS.

As the insects so destructive to the apple-crop may soon be expected, my way of driving them away may be useful to persons who have had their crops destroyed by them. On an orchard of 13 acres, for nine successive years both blossoms and leaves were completely destroyed by caterpillars, when I commenced smoking them; and for the next ten years I never lost the crop.

The smoking is done by placing a large iron coakel on four low wheels, and putting dry wood, with any weeds or rubbish, and some brimstone into it, and forcing it to burn by large bellows, which drives a strong and continual stream of disagreeable smoke through a moveable tube to every tree, and every part of a tree, in succession; and by constantly commencing on the windward side of the orchard, and following up row by row till the black apple-fly and moth disappear, I prevent their producing the caterpillars, and consequently save the crop.

*Barming, near Maidstone,
14th April, 1843.*

II.—*On Burning Clay.* By ELI TURVILL.

BURNING land is much practised in the Roothings, containing nine parishes, and adjacent parishes, High and Good Easter, Roxwell, Mashbury, Pleshey, over a country about 10 miles from south to north, and from 5 to 6 miles from east to west. The expense of burning land is from 20*s.* to 25*s.* per acre, according to the previous state of the land and the present price of labour. The fuel generally used is a good wagon-load of haulm per acre; some give a small quantity of brushwood which is trimmed from the brows of hedges, or a portion of bean-straw in addition. Some burn the heaps at 4 perches square, 40 per acre, and each heap is expected to contain 3 yards of ashes. Some burn the heaps at 8 yards square, 75½ per acre, and each heap is expected to contain 2 yards of ashes. The 8-yard fires cost 2*s.* to 3*s.* per acre more than the 4-perch fires. The whole of the ashes are spread, and the land fallowed in the usual way. It is repeated every four to six years, as may suit the rotation of crops. It is an excellent preparation for all kinds of corn; on the thin skin land white turnips are grown well after burning; it absorbs the water, the land dries earlier, can be worked and

sown sooner in the spring. The improvement on the crop amply pays for the outlay, as well as having the land much better for the following crops. Burning is a fertiliser to the soil, and the oftener it is burned the more it improves the staple and quality of the land. So far from destroying the soil, it acts greatly to its improvement, and is highly conducive to the growth of the cultivated crops; the effects may be seen more particularly in the clover. It is too early in the season to send some ashes, or clay which has been burnt.

Mr. F. Mathews, of High Easter Land, owner and occupier to a considerable extent, burns all he can, and allows his tenants to break up old pasture, provided they burn.

III.—On Burning Clay. By LITCHFIELD TABRUM.

To T. W. Bramston, Esq.

MY DEAR SIR,—It is thirty years since I began the system of burning earth for manure, on a very small scale, in an imperfect and very expensive manner; but in a few years afterwards I reduced it to a regular course of farming, commencing by sowing from 10 to 12 lbs. of the *best* trefoil seed, and from 4 to 6 pecks of rye-grass per acre, on the exhausting wheat crop, *early* in the spring, having it harrowed and rolled in, the expense of which is amply repaid by the autumn and spring feed it produces, enabling a much larger flock of sheep to be kept. There is a twofold advantage in being *liberal* in the quantity of seed sown—that is, in the quantity of feed and in the increase of herbage, which materially assist the burning, and much improve the quality of the ashes.

It is highly necessary to have the land well under-drained before it is burnt. I drained nearly all the Bury Farm about 4 yards apart (some only 3 yards, *which paid the best*) before I burnt it. I have now made up my mind to have them only 6 or 7 feet apart, and from 16 to 18 inches deep, with the *mole-plough* and 16 horses. I have proved it *positively* by experience that the mole-plough on the clay lands is far superior to the spade, independent of the comparative small expense of the former. If you *observe* as the mole of the plough moves on, you will see the earth heave up near a *yard wide each side* of the plough, and it loosens the subsoil much more effectually, in my opinion, than any other plough made for that purpose, and prevents the possibility of any stagnant water remaining on the land. It might then always be sown on the flat or Kentish mode, instead of the old-fashioned Roothing *ridges*, or *high-back* stretches—that is, if it is followed up by effectual burning about once in six or eight years, with an intermediate coat of yard manure or folding, and would *double* the

returns of much of the Roothing land, both as to stock and crops ; and (what seems to be so much overlooked by most of the landed proprietors, but what I consider, in *these times in particular*, of infinite importance) it would enable the farmer to employ *double* the number of labourers to advantage, and eventually increase the value of the land *full 25 per cent.* I believe I was the first who introduced the system on the clay lands ; and although it cost me, for several years, 1000*l.* per annum for labour, on little more than 500 acres, I am perfectly satisfied with the result as to myself, and I know the farm is let for more than 30 per cent. more to the present tenant. I state this, sir, to satisfy you of the *permanency* of the improvement. I give your bailiff, Eli Turvill, much credit for the business-like manner in which he has stated the particulars—resulting, as they must, from an observing and inquiring mind ; and I think what I have stated here, from *practical experience*, fully bears him out. If you follow this system out, it will, from the number of labourers necessary, require the *vigilant eye* of the master to do justice to it.

I could say much more in favour of burning were I to go more into detail as to the results from my burning for the last twenty years, but I fear I have already troubled you too long.

I am, &c.

LITCHFIELD TABRUM.

Bois Hall, 27th March, 1843.

IV.—On White Carrots. By GEORGE TURNER.

THINKING that the merits of the white or Belgian carrot are not sufficiently known and appreciated, and having been a grower of them on a small scale for some years, I am induced to forward an account of my crop on one small piece this year. The plot on which they grew was rather less than 37 poles ; and the produce, exclusive of tops and tails, quite free from dirt, 7 tons, or full 30 tons an acre. They were drilled the 9th of April in rows 15 inches apart, and of course well hoed ; the land a strong gravelly loam in good condition, but not exactly the sort of soil adapted for carrots ; it was ploughed tolerably deep and well worked, manured with a very moderate quantity of well-rotten dung ; a small quantity (I believe about 10 bushels) of wood-ashes, was sown over after drilling, and lightly raked in. I have them stored as usual in a shed, and intend them for horses, cattle, and sheep in the spring, all sorts of stock eating them with avidity, and fattening fast on them.

Barton, near Exeter, Jan. 7th, 1843.

V.—*Experiments on Different Manures for Carrots.*

By J. M. AYNESLEY.

<i>Red Altringham Carrots.</i>						
	Weight of each Perch.	Weight per Acre.	Weights of Tops per Acre.	Manure used.	Quantity per Acre.	Cost per Acre.
No.	lbs.	Tons. cwt. lbs.	Tons. cwt. lbs.			£. s. d.
1	270	19 5 80	7 10 0	Coal-ashes . .	24 tons .	4 4 0
2	299	21 3 64	8 0 0	Rape-dust . .	8 cwt. .	2 11 3
3	295	21 1 48	8 2 96	{ Daniel's patent manure . . }	32 bush. .	1 14 0
4	301	21 1 0	8 4 32	Bone-dust . .	24 bush. .	4 2 6
5	314	22 8 64	8 4 32	{ Salt, 6 bush. . }	60 bush. .	2 2 6
6	307	21 18 64	8 2 16	{ Soot, 54 bush. . }	24 tons .	4 16 0
				Stable-manure .		
<i>White or Belgian Carrots.</i>						
1	350	25 0 0	8 16 8	Coal-ashes . .	24 tons .	4 4 0
2	381	27 4 32	9 2 96	Rape-dust . .	8 cwt. .	2 11 3
3	380½	27 3 64	9 7 16	{ Daniel's patent manure . . }	32 bush. .	1 14 0
4	365	26 1 48	9 15 80	Bone-dust . .	24 bush. .	4 2 6
5	412	29 8 64	9 14 100	{ Salt, 6 bush. . }	60 bush. .	2 2 6
6	398	28 8 64	8 11 48	{ Soot, 54 bush. . }	24 tons .	4 16 0
				Stable-manure .		

The antecedent crops were, in 1840, potatoes, manured with stable-dung; in 1841, beans.

The seed was hoed in upon the 19th of April, at the rate of 8 lbs. per acre. The white carrots were pulled on the 4th of November, the red on the 21st. The soil was a clayey loam, 1 foot in depth, resting on a stiff clay.

The unmanured carrots were not weighed, but the white were supposed to be about 20 tons; the red 16½ tons per acre.

The present crop is wheat hoed in on the 3rd of December; all looking well, though rather too rank; the coal-ashes and stable-manure rather the best. All the manure was bought in Bristol. I have charged half-a-crown as back-carriage for hauling it out, the distance 8 miles, upon a good turnpike-road.

Fern Hill, Tockington,
1842.

VI.—*On the Black Foxtail Grass (Alopecurus?).*

By W. P. TAUNTON.

To the Secretary.

SIR,—I have the honour to transmit by the mail of the 1st of May a specimen, cut on the 30th of April, of *Alopecurus nigricans*, a Siberian

perennial, grown on strong woodsour clay over the chalk, at an elevation of some 500 or 600 feet above the level of the sea, in a tolerably well sheltered situation, but without any extraordinary manuring. I submit this to the inspection of the next committee, who will perceive that, before the 1st of May, some of the stalks have put forth their flowers, and that the longest stalk has attained the length of nearly 3 feet 5 inches. Its bulk, hardihood, succulence, and precocity inspire me with the hope that the committee will think that, in pursuing the culture of this grass, I shall be making a useful acquisition to English husbandry. It thrives in the same soils as the other foxtails, a rich silicious soil with a competent mixture of argil, and grows freely from seed, provided it be not compressed in the earth, but sown on the surface; and an experiment I accidentally made indicates that it will prove peculiarly valuable in water-meadows, as it thrives in humid places.

Yours, &c.,

W. P. TAUNTON.

Ashley, April 30th, 1841.

P.S.—I thought it better to send this specimen now, because if any gentlemen of the Council have recently left their own meadows or pastures in the country, they will be better able now, than in July, to appreciate a grass whose height exceeds 3 feet on the 30th of April. We have neither rye nor winter oats at this day equally full or productive.

VII.—On some Varieties of the Foxtail Grass (*Alopecurus*).

By W. P. TAUNTON.

To Ph. Pusey, Esq.

SIR,—I am honoured with your inquiry touching *Alopecurus nigricans*. I am sorry that it is not in my power to communicate any scientific information, nor the result of any precise experiments, on the subject. The plant appearing to me so early and so bulky, and feeling confident that it possesses qualities analogous to those of other *Alopecuri*, of which we have my valued friend Mr. Sinclair's analysis, I have bent my whole efforts to increasing my stock of it, rather than to experiments on the use of it. This year I hand-reaped the heads, and afterwards mowed the lower part of the culm with the foliage, and gave it to a cow tied up in house, and to a colt and horse in stable. They all ate it freely and eagerly; but I have no further observation recorded concerning it. The seed is ripe in the first week in June, which gives the opportunity of sowing it early enough to have the plant well established in the ground before winter—an advantage of great importance in those soils which are liable to a great degree of expansion from frost, and in that operation throw the infant grasses out of the soil, to perish under the March winds and May suns. I have not the advantage here of occupying any land of a texture of soil the most congenial to the foxtails. Their favourite habitat is a loamy silicious moist sand, such as the green-sand

formation in the Vale of Pewsey, Wilts, and Vale of White Horse, Berks ; where you may see our native foxtail attain the height of 5 or 6 feet in the moist meadows. It is not a thing usually to be expected that an exotic should be capable of being cultivated more easily and effectually than our native plants of the same genus ; yet I am inclined to think that such is the case with two or three of the foreign foxtails. I have rarely examined the seed of the English meadow-foxtail without finding a very large proportion of it possessed by an insect, which has been bred in the seed, and, after feeding on the grain, has gnawed its way out, and left a round orifice to tell the tale. Hence, out of a bushel of seed thereof, which is always dear, a very small proportion is in a vegetative condition ; and the inexperienced meadow-maker vents his complaints on the ill-treatment he has received from his seedsman—as if the seedsman had laid the eggs of all the maggots in the crop. Now I have scarcely ever observed any of the seeds, either of *Alopecurus nigricans*, *A. arundinaceus*, or *A. agrestis* (perenn.), of some German botanists, on which my partial friend bestowed the appellation of *A. Tauntoniensis*, to be perforated by this or any other insect ; and an equal quantity of the seed of either of these sorts appears to me to afford a greater number of plants than the like bulk of meadow-foxtails. This, then, is an advantage in the foreigners. Another advantage, I think, is that the seeds of all these three foreign sorts, when perfect, are of a dark colour, varying from a slate-coloured grey to jet-black, according to their degree of ripeness and fullness ; for the flower-spikes of these and of the meadow-foxtail equally are liable to be blighted or injured by unseasonable spring frosts, or some other cause. When this happens to the meadow-foxtail, there is no easily distinguishable difference of colour between the blighted heads and the ripened heads ; and, as I doubt whether seeds-men usually winnow the grass-seeds they sell, the blighted or frost-bitten heads introduce another element of disappointment into the bushel of meadow-foxtail seed, for which you have paid from 12s. to 15s. The three foreign sorts, however, disclose to the eye at a glance what proportion of the contents of the bushel has been rendered worthless by this cause, and what valuable ; for the blighted and frost-bitten heads of all these three sorts are white, like the meadow-foxtail. But a more important advantage than the foregoing is that, according to Mr. Sinclair's analysis, *A. Tauntoniensis*, at the time of flowering, possesses treble the proportion of nutritious matter which our native meadow-foxtail possesses ; and *A. arundinaceus* more than treble of that proportion. (See 'Hort. Gram. Woburn,' pp. 140, 231-33.) The latter, to the best of my recollection (for I have lost sight of it for several years), though taller and more bulky, does not produce so many radical leaves as our native species : the *A. Tauntoniensis* is not quite so bulky as the native sort, I think, but is well garnished with radical leaves. Your skilful and respected member Humphrey Gibbs, Esq., says that *A. arundinaceus* is more productive than *A. nigricans*. As I have never had them in cultivation together, I have had no opportunity to compare them ; but *A. nigricans*, with me, gives a greater burthen than *A. pratensis* or *A. Tauntoniensis*.

In the sowing of these grasses on a stiff clay, I persuade myself I have learned, from experience, that repeated rollings immediately after

sowing—which, in putting in all other grass-seed, I have found to be eminently beneficial, if the ground was dry and well pulverized—have not assisted the growth of these foreign foxtails; but that, on the contrary, such parts as I sowed without rolling-in succeeded abundantly, while those which I rolled gave me very few plants. This effect may be limited to my peculiar clay soil, or to the state of the soil, or it may be general. I merely throw out the remark to the intent that, if you should take these foxtails into cultivation, you may repeat the experiment, and adopt the practice which you shall find most successful.

A valuable quality of the foxtails is, that thick radical leaves retain their verdure to a late period of the summer, particularly in moist ground: hence, if, through coveting a larger hay crop, you let your grass stand till the later species, as catstails, &c., are in blossom, you do not experience a total loss in your foxtails: whereas, some early grasses—as, for instance, *Avena pubescens*—have entirely lost their radical leaves soon after their flower has unfolded.

I have in cultivation another valuable early grass, nearly allied hereto. I received it under the name of *Phleum hostii*; but, to my ignorant and unbotanical eye, it looks not like a *Phleum*, but exactly like a foxtail. It is very productive of seed, rather heavier than any foxtail, shaped like a foxtail seed, and of a light honey-colour, or slightly tawny-yellow. It is clearly not our meadow-foxtail. It is about a week later than *A. nigricans* and its black brother; and has the valuable property of thriving well, and coming thus early, on a stiff cold clay. When you recollect that though we have many nourishing pastures on clays, they consist almost wholly of late grasses, you may be disposed to think that a tall productive grass, which will come early on such soils, is well worth attention, whatever its name be. From its great similarity in habit, growth, shape, and earliness, I have been induced to subjoin the mention of this to my wearisome discourse upon foxtails, which I will here end by saying, that, if you wish to cultivate *A. nigricans* on a farmer-like scale, Messrs. Booth, Hamburg, will have it for sale this year, for the first or second time; therefore their quantity will probably be limited, and an early application may be therefore advisable.

I remain, Sir,

Your very obedient servant,

W. P. TAUNTON.

Ashley, Stockbridge, Hunts,

July 25, 1842.

VIII.—On Pipe-Tiles. By JOHN READ.

To Ph. Pusey, Esq.

[This account arrived too late to be included in the article on Under-draining.]

SIR,—I beg to inform you that I am just returned from the Weald of Kent, after taking a survey of the land on which I commenced the process of under-draining in the year 1788, the good effects of which are to

be seen to this day ; also the kiln which I built for making tiles, which is now occupied by my nephew, who is making pipe-tiles, with the same machine as those made at Horley in Sussex. I then went to Penshurst to see the effect of the same kind of tiles ; the previous day having been very wet, gave me a favourable opportunity of examining them. In a field from 30 to 40 rods across, on a declivity shelving towards the road, the drains emptied into an open ditch, I saw twenty-three drains made in parallel lines from top to bottom of the field ; the water ran in a clear stream about the size of my finger. Mr. Hammond (the tenant) informed me that the day before the stream filled about half of the tile. Mr. Hammond also told me they were making tiles at a kiln about a mile distant ; I went there and saw the same machine, the master and his sons at work making the tiles. One kiln of 12,000 was ready to draw the day following. They purpose making 100,000 during the summer ; 12,000 are all they can burn in one kiln. From the experience I have had in draining, I think tiles of *various sizes* will be required ; for instance, land that is level, or nearly so, requires larger tiles than upon a descent ; and again, in a length of 40 rods, a larger tile will be required at the *bottom* than at the top of the field. To accomplish this object I propose making them of four different sizes, to suit different opinions, as well as for convenience of burning as many as possible in one kiln, by placing one pipe within the other ; by this means 24,000 may be burned in the space of 12,000, and with the same fuel. The above kiln may be seen at Penshurst in Kent, about 2 miles from the station on the *Dover Railway*.

Any gentleman wishing to see the above works may leave town by the Dover Railway, survey the land, see the process of making tiles (there being no patent for them), and return to London within 8 hours from the time of leaving.

The price of the tiles is 2½s. per thousand taken from the kiln.

*Regent's Circus, Piccadilly,
May 10th, 1843.*

Yours, &c.,
JOHN READ.

P.S.—I think the above is the best, cheapest, and most durable system of draining I ever saw.

IX.—*Experiment on the Feeding Properties of Swedes and of Mangold-Wurzel.* By C. HILLYARD.

To prove the comparative feeding qualities of mangold-wurzel and Swedish turnips, I put into my stalls, on the 4th of January, 1843, six three-years old Hereford steers, all of one person's breed, divided as equally as possible as to weight, frame, and quality.

The six beasts were slaughtered by Mr. Giblett, and the carcasses shown in his shop on Monday the 1st of May.

The following fed on Mangold-Wurzel.

	Estimated Weight when put in the Stalls.		Dead Weight of Carcass.		Increase of Weight.
	Stones of 8 lbs.		Sts. lbs.		Sts. lbs.
No. 1.	. . 74 . .		87 6 . .		13 6
No. 2.	. . 76 . .		92 1 . .		16 1
No. 3.	. . 74 . .		89 3 . .		15 3
	<hr/>		<hr/>		<hr/>
	224 .		269 2		45 2

Whole increase of weight . . 45 stones 2 lbs.

Loose fat 25 stones 5 lbs.

The following fed on Turnips.

	Estimated Weight. Stones of 8 lbs.		Weight of Carcass.		Increase of Weight.
	Stones of 8 lbs.		Sts. lbs.		Sts. lbs.
No. 4.	. . 76 . .		99 2 . .		23 2
No. 5.	. . 74 . .		85 6 . .		11 6
No. 6.	. . 74 . .		89 7 . .		15 7
	<hr/>		<hr/>		<hr/>
	224		274 7		50 7

Loose fat 24 stones 7 lbs.

Increase of weight exceeding the increase
of those fed on mangold-wurzel } 5 stones 5 lbs.

According to this trial, the comparison of the nutritive qualities appears to be in favour of swede turnips. My mind not being satisfied by this trial, I intend, on the 1st of November, to try six other beasts that will have been grazed through the summer. The beast No. 1 disappointed my expectations ; I thought he would have increased quite as much, if not more, than any one of them ; but, proving in the stalls of uneasy temper, his increase of weight was, one excepted, the least.

The weekly cost of the feeding of each beast was as follows:—

	s.	d.
10 lbs. daily of cut hay, at 3s. per cwt.	2	0
Linseed, 1 quart, boiled, cost at home	1	6
Barleymeal, 3 quarts daily	2	0
(These well mixed together, given in 3 feeds.)		
1½ bushels (in 3 feeds), daily, of mangold or of turnips	2	6
	<hr/>	
	8	0

The cost of keeping each for 16 weeks in the stalls, £6. 8s.

Each beast sold for 4*l.* more than its value when put in the stalls : this is paying rather too much for the improvement of the manure ; still there should be some stall-feeding on what are called turnip-land arable farms. On some clay-land, if not very stubborn, mangold, with good cultivation, may be produced better than Swedish turnips.

X.—*On Nitrate of Soda.* By W. CLARKE.

To T. D. Acland, Esq., M.P.

MY DEAR SIR,—The nitrate of soda which I tried last year was as under:—The field was manured all over alike on a clover ley sown with wheat, in the month of November, 1841; on the 7th of April, 1842, I marked out 120 poles running from one end of the field to the other, leaving $54\frac{1}{2}$ poles thus in the middle of the field:—

60 poles nitrate of soda.
$54\frac{1}{2}$ poles without.
60 poles nitrate of soda.

The wheat on the 120 poles sown with $\frac{1}{2}$ cwt. of soda soon showed itself much stronger in plant and colour. The land is what we call stone-rush, situation rather high, aspect good. At harvest I was particular in keeping it separate, the more so on account of the conflicting opinions I read in the Journals of the Royal Agricultural Society on the subject. On the 17th of December last I threshed and winnowed up the two lots, and the result was, 120 poles produced 28 bushels, and the $54\frac{1}{2}$ poles produced $11\frac{1}{2}$ bushels, or just $4\frac{1}{2}$ bushels per acre more with soda.

	£.	s.	d.
$4\frac{1}{2}$ bushels wheat, at 6s.	1	5	6
$\frac{1}{2}$ cwt. nitrate of soda	0	15	0
Profit	0	10	6

Besides a little more straw, which will make a little more manure for next crop; and again, wheat is now very low.

I am, &c.

W. CLARKE.

East Lynch, near Minehead, Somerset,
Jan. 13, 1843.

XI.—*Account of the Effect of a Bituminous Shale at Christian Malford, Wilts.* By ROBERT GOWEN.

HAVING been requested to give some account of the bituminous shale, the fertilising qualities of which attracted my notice some years ago at Christian Malford, an estate belonging to the Earl of Carnarvon, near Chippenham, in Wiltshire, and situate in the valley of the Avon,—I have to state that I was at that time the auditor of the property, and had directed the deepening of an ancient watercourse, called Pug Ditch, which runs through the parish. The labourers, being engaged on a portion of the watercourse where the soil rests upon a substratum of gravel, the rubble of the neighbouring coral rag, cut through a number of highly-inclined out-croppings of dark-coloured shale, belonging to the

Oxford clay formation, which underlies the coral-rag gravel. In the course of the ensuing summer the gravel, which had been thrown out of the cutting upon the land, being much esteemed, was all carted away, but the shale was left undisturbed. Late in the winter, or early in the spring, an application was made to me by the tenant of the land for an allowance for the expense of carting away the shale which encumbered it, when, accompanied by the bailiff, I repaired to the meadow in order to ascertain what was fitting to be done. I observed with interest around the edge of each heap a circle of dark green and luxuriant grass, such as would have surrounded a heap of rich manure. I also observed that the frost was breaking down the shale into powder. These circumstances I pointed out to the farmer as indicative of a fertilising property in the substance, and, recommending him to draw it out on his land immediately, I declined making him any allowance. A few months afterwards I learned that he had followed my advice, with the excellent result of a heavy crop of hay and aftergrass, which I witnessed with satisfaction. He died not long after; his occupation is now subdivided between contiguous tenants, and I am unable to give you more than this my general recollection. I may add that, when I was impressed with the fertilising properties of the shale, I also saw that it was bituminous, and found that upon placing a fragment in the fire, it emitted considerable flame. I have now procured a lump of it, and have had it examined by a friend, a very accomplished chemist, who informs me that a proximate analysis brings out the following results:—

Combustible matter, chiefly bituminous	. 206
Silica . . . . .	. 321
Alumina . . . . .	. 130
Lime . . . . .	. 116
Oxide of iron . . . . .	. 109
Magnesia . . . . .	. 5
Carbonic Acid, &c. . . . .	. 73
Water . . . . .	. 40
Phosphoric acid and alkaline salts, a trace.	—
	1000

which may be taken as a near expression of its constituents.

It seems to be very probable that this substance owes its fertilising properties mainly to the bituminous matter which enters so largely into its composition. It is not of unfrequent occurrence, and may be deserving of attention. The bituminous shale so common in coal-measures, when possessed of the property of breaking down by the action of frost, may be very useful upon gravelly soils.

*St. James's Street, London,
March 31, 1843.*

XII.—On Purifying the Air of Stables by a mixture of Gypsum or Sawdust with Sulphuric Acid. By HENRY REECE.

HAVING been invited by Mr. Evans, of Dean House, Enstone, to make some experiments on his excellently-conducted farm and stables, I trust the results of those upon the absorption of ammonia may prove of sufficient interest to entitle them to publication. As gypsum (crystallized sulphate of lime) had been highly recommended for this purpose in some recent works on agriculture, the stables were in the first instance freely strewn with this salt coarsely powdered; but though the ammonia was evolved during the removal of the wetted straw in sufficient quantity to affect even the eyes of the grooms, I could not, after two days' exposure, detect the slightest trace of it in the gypsum when I examined it with slaked lime. This result was the more surprising, as it is known to every chemist that solutions of carbonate of ammonia and of gypsum are incompatible; the carbonic acid leaving the ammonia to form the precipitate carbonate of lime, the sulphuric acid passing to the ammonia; and I had previously ascertained that in an atmosphere so highly charged with ammonia as to be destructive to animal or vegetable life, a very appreciable proportion was taken up by wetted gypsum. The following experiments appeared conclusive upon the point, that under less favourable circumstances not an atom was absorbed: 200 grains wetted with distilled water were exposed in a close stable for three days, precautions having been taken to avoid any error from evaporation: it was again weighed, no increase could be perceived, nor was any ammonia evolved on the application of the usual tests; while 200 grains wetted with diluted sulphuric acid, and exposed the same time, were found to have gained 36 grains of ammonia. The stables were then strewn with the gypsum moistened with sulphuric acid, and examined the next morning: every portion was found to have absorbed sufficient ammonia to evolve its peculiar pungent odour when brought in contact with slaked lime; the stables had also lost their close, unhealthy smell. To use the words of the grooms, they appeared sweetened. As it was evident the gypsum acted merely mechanically, affording a convenient absorbent surface for the acid, experiments were made, substituting sawdust for gypsum with even more favourable results. That the proportion of free ammonia in stables is very large may be shown by the simple experiment of placing a moistened piece of litmus-paper reddened with weak acid in a stable: in one badly cleaned or ill-ventilated the effect is instantaneous; but even in those of Mr. Evans, where the greatest attention was paid to these points, the paper was observed in a few minutes to become blue; even the water kept in the stable the over-night, as is the habit to take off the chill, becomes sufficiently impregnated with ammonia to affect tests. As this alkali is justly ranked among the most powerful stimulants, the continual breathing of an atmosphere vitiated by it can hardly fail to have a prejudicial effect. Grooms are observed to be short-lived; and the rapid course of inflammatory diseases in horses, and their distressing predisposition to colds and affections of the chest, are no doubt greatly aggravated by this cause.

The increased salubrity and sweetness of the stable, if pointed out to the grooms, would therefore soon reconcile them to the slight additional trouble the adoption of this remedy would incur. At Dean House the acid gypsum was first strewn amidst the straw; but as this was considered likely to injure the feet and clothing of the hunters, it was afterwards spread on trays. One part of sawdust will be found to absorb readily three times its weight of acid solution, which I made with one part, by measure, of sulphuric acid to fifteen of water. If intended to be tried as a manure, it should be mixed in with the straw when removed from the stable. During the process of rotting, the ammonia is evolved so freely, that at the end of two or three weeks the acid powder, which should not remain more than three days in the stable without changing, will be found completely neutralized; and as the greatest benefit was derived from covering up and salting dung-heaps, by which I believe an additional absorption of ammonia could only have been gained, it may be reasonably hoped that an increased value would result from a manure thus surcharged with ammoniacal salts.

Medical Hall, 168, Piccadilly.

XIII.—*Additional Remarks on the Failure of Red Clover after Harvest.* By the Rev. W. THORP.

I BEG leave to state that I am extremely obliged to the Duke of Portland for correcting the explanation which I have given of the failure of the seeds upon some fields near Clumber Park.*

Upon referring to the original letter of the Duke of Portland, as reprinted from Bell's Weekly Messenger, in vol. ix. of the Quarterly Journal of Agriculture, I find that two fields had been manured with bones solely, for a period of thirty years; that one half of each of the fields, as an experiment, was manured with farm-yard dung, and the other half with bones, as usual, for turnips. The seed failed upon the boned portions; *they had died away before harvest.* The seeds were re-sown on the stubbles, but died away again in about six weeks; were again re-sown in spring, and manured with dung, but produced only an inferior crop.

These fields therefore ought not to have been adduced by me as cases in point; for it is stated in the commencement of the article (p. 327), that it is concerning the failure of the clover crop *after harvest* to which the remarks would be directed.

The "Agriculturist"† who reprints the Duke of Portland's letter ascribes the failure of the seeds to the four-course shift of—1. turnips—2. barley—3. clover—4. wheat,—which he says is not adapted to any sand-land, with even an unlimited command of manure; for that course keeps light land too much under the plough, pulverising it too much,

* Journal, vol. iii. p. 335.

† Agriculturist's Note-Book, p. 102.

and thereby endangers its texture with deafness. But there seems very little doubt that as both potash and gypsum are necessary constituents of seeds, * *i. e.* of cow-grass, white clover, trefoil, and rye-grass, of which these seeds, as I am kindly informed by the Duke of Portland, consisted, and as neither of them is contained in bones, the boned lands failed in consequence of the absence of either the one or the other, or perhaps of both of these substances.

In order, however, that the argument offered concerning the cause of failure of the clover *after* harvest (*viz.*, that it is destroyed by the frost, and this in proportion to the want of a certain degree of cohesive-ness of the soil) may not lose any of its value by the abstraction of the supposed examples of the boned lands, allow me to mention that three expedients have been tried in Scotland to remedy the failure of red clover:—

1. Sowing it at longer intervals.

This plan is said to have succeeded in partially recovering the former luxuriance of the crop. However, in Yorkshire, upon the magnesian limestone, from inquiries of my own, out of 250 acres which were good after harvest, and which were sown at an interval between the same crop of *not less* than twelve years, 147 acres failed. (See Yorksh. Agric. Report, p. 123.)

2. Manuring the land more liberally.

This to a certain extent has effected an improvement.

3. The plan which has succeeded most effectually is, *by allowing the land to remain for a longer period in seeds*; and from three to five years is now found the proper time. The editor of the Farmer's Magazine (p. 170, for March, 1841) says—"However paradoxical it may seem to state it as a general principle, that the repetition, or rather duration of a crop which the land is tired of growing, is the best means of inducing that land to grow it the more luxuriantly, there is no denying the soundness of the principle in regard to clover: there is no denying that where the experiment of allowing clover to remain a number of years, that is, white clover (for red clover is only available for one year) to be depastured by stock, has been tried, there the growth of red clover has become almost certain."

My theory explains this seeming paradox; for the longer any land is kept from the action of the plough, and the more it is trodden by sheep, the firmer does it become; the particles, particularly the silicious, unite more firmly by the force of homogeneous cohesion, and the soil is reconsolidated; and hence, for reasons before mentioned, the clover is not affected by the frost.

I wish also, in corroboration of the truth of the theory, to name the practice of a magnesian-limestone farmer, who has upon the same land grown red clover every fourth year for thirty years, while the owners of the adjoining fields cannot produce it even every twelfth year, with the same certainty that it will endure the winter. 1. He gives the clover ley, when broken up for wheat, a good dressing of caustic lime, which not only rots out much sooner the vegetable matter, but also gives a certain

* See Lectures on Agric. Chemistry, by Prof. Johnstone, No. xv. p. 323.

degree of tenacity to the soil, and kills the slugs and worms. 2. He presses the soil for wheat. 3. Always eats off the turnips with sheep. 4. He now presses the land for barley in the same manner as for wheat; and I advised him to make doubly certain by rolling the clover immediately after harvest, which the farmers of Campsal are doing with very beneficial effect.

Again, there is through the greatest part of Yorkshire a strong geological proof of the truth of the theory. From Tadcaster to the borders of Nottinghamshire, the magnesian limestone formation consists of two beds of rock, with a bed of red marl interposed between them: the latter forms a strong land, and when drained artificially or naturally by a steep inclination, produces excellent seeds and red clover. Now, wherever the red marl and upper rock form one hill-side, and a single field of clover extends over both, or contiguous fields are producing this crop at this time of the year, the boundary of the strata is marked out with the greatest precision, either by the inferior quality or total absence of the clovers upon the rocks, which form comparatively light or pulverulent soils.

I beg leave to add that I feel the more obliged by the Duke of Portland's correction, because there are few men who, without the slightest ostentation, have so much advanced the best interests of agriculture.

*Womersley Vicarage, near Pontefract,
17th February, 1843.*

XIV.—*Experiments on Manures.* By FRANCIS CLOWES.

To James Hudson, Esq.

DEAR SIR,—Some time since I promised I would send you the result of some experiments I was then trying, and I now take the liberty of so doing, and adding thereto some of more recent date. In the early part of June, 1841, I was induced to try saltpetre and nitrate of soda at 1 cwt. per acre, and salt and lime at the rate of 30 bush., but unfortunately during harvest the several plots became so intermixed, I could not arrive at any satisfactory conclusion, but so far as the eye may be relied on—which by the way is very, very little—I may perhaps be allowed to say that in the barley on which it was tried I could not see any superiority, while in the wheat, where it was also tried, I could at harvest plainly see a superiority of as much as 6 inches in the length of the straw, and a finer ear; and I think the finest ear and longest straw were where the salt and lime were applied, which also killed all grass and weeds growing among the wheat, while the other two evidently nursed it up; but as I cannot say anything about the weights and measures of each, my experiments are of little use, although I am thankful to say my land is of that quality, my barley may easily be spoiled by sheep-feeding turnips, and my wheat the same by too high farming. I will now turn to some few experiments on grass and turnips, and here weight and measure must speak for themselves; and it may not be out of place to observe,

the experiments on grasses are all carried on in square chains, and therefore I have necessarily taken the tenth of the usual quantity of manure applied to an acre of land for each plot: the turnips are manured by the acre and weighed by the square chain. The parish of Hemsley, in which my farm lies, is on the seacoast, about 6 miles to the north of Great Yarmouth; the fields on which the experiments were tried are all within $\frac{1}{2}$ mile of the sea; the soil is of a mixed freeworking loam, varying from 2 to 4 feet in depth, with a subsoil of brick earth and field clay. The grasses, trefoil or yellow clover, white clover, and the common rye-grass, were of the first year's lay.

On the 7th of April, 1841, the following manures were sown broadcast:—

No.	Manure	cost, cartage, &c.,	s. d.		produced	Cwt. qrs. lbs.			
			s.	d.		Cwt.	qrs.	lbs.	
No. 1.	11½ lbs. of saltpetre,		3	3	5	2	0	0	of hay.
2.	11½ lbs. of nitrate of soda,	do.	2	8	do.	5	0	0	do.
3.	1 ton of fish-mould,	do.	2	0	do.	4	3	23	do.
4.	1 ton of fresh stable-manure,	do.	2	0	do.	4	3	19	do.
5.	5 bush. of salt and lime,	do.	5	0	do.	3	3	8	do.
6.	Soil simple,				do.	4	0	11	do.

The grass was mowed and strewed on the morning of the 15th of June, and weighed on the 17th in the afternoon, at which time it was in a fit state for carting, it having been very fine weather; very shortly after the manures were put on, I could plainly see a difference in the colour of the grass in Nos. 1, 2, and 3, and when cut, No. 3 was, to all appearance, the best, at once pointing out the fallacy of the eye. I have valued my hay at 4s. per cwt., and notwithstanding my loss in No. 5, and after deducting the expense of the manures, I have a net profit of 1s. 4d. on the whole of the above experiments, and showing a gain of 2s. 9d. net in No. 1 over No. 6.

The same year, on the 13th of April, with similar grasses and soil, in a field rather nearer the sea than that just described, I had the following manures sown broadcast: as you will see, when compared with the last field, I have used half the quantity of salt and lime, and double that of saltpetre and nitrate of soda, with the same of fish-mould and stable-dung:—

No.	Manure	full cost,	s. d.		produced	Cwt. qrs. lbs.			
			s.	d.		Cwt.	qrs.	lbs.	
No. 1.	2½ bush. of salt and lime,		2	6	3	3	0	0	of hay.
2.	23 lbs. of nitrate of soda,	do.	5	4	do.	6	0	25	do.
3.	23 lbs. of saltpetre,	do.	6	6	do.	5	2	15	do.
4.	1 ton of fish-mould,	do.	2	0	do.	4	3	0	do.
5.	1 ton of stable-dung (fresh)	do.	2	0	do.	3	1	9	do.
6.	Soil simple,				do.	3	3	2	do.

The hay was mowed and strewed on the 16th of June, and weighed on the 18th, when in a fit state for carting: it will be seen that nitrate of soda here has the best of it, and that, setting my hay at 4s. per cwt., I am a gainer in this field of 1s. 2d. on the whole of the experiments; by No. 1, I lose the cost of the manure, and by No. 5, I lose 1s. 9d. worth of hay, beside the cost of the manure: and thus I account for my loss in No. 5—the stable-dung being set on late, and being long, did not wash into the land enough, consequently the grass was not mowed so low by some 2 or 3 inches as on the other squares.

In 1842 I tried similar experiments on red clover; but after the

manures were put on, unfortunately the clover, owing to excessive draught, fell off by spots all over the field, thereby preventing my arriving at any satisfactory conclusion; but this I could see, where the previous autumn I had put on sea-weed, gathered from the beach as the water washed it up, and put it on the layer at the rate of 15 tons per acre, the clover was not only thicker on the land up to the time of mowing—not even suffering from the drought which affected the rest of the field—but could be plainly seen all through the winter, looking a deeper green, having a broader leaf, and by being in a riper state for mowing for hay than the rest of the field at the proper time.

I have never yet been able to discover any superiority on those parts where the above manures were tried, either in the after-grass or the wheats, although it is much too early yet to judge of the wheat now growing.

Perhaps it is time I should say a few words on some of the manures used: the fish-mould consisted of a grampus weighing about 3 tons, which was washed on shore near this parish; I procured it, and after dragging it by sea to within a quarter of a mile of the field in which it was to be used, it was landed and dragged by twelve horses to its *pro tem.* resting-place: here it was cut into pieces of about 3 stones each, and packed up in alternate layers with mould, chalk, or, as we call it, marl, and lime; and finally all was well covered over with mould and grass from the sides of the fences: it lay for about nine or twelve months before it was used, and during this time it was turned frequently to incorporate. The salt and lime compound was prepared in the winter, precisely after the directions given by C. W. Johnson, in his work on Manures, or, as he more truly calls them, “Fertilizers,” chapter the 16th, p. 408; and so far as my experience goes, as a top-dressing for grass and a manure for turnips, it will not do at all; whilst as a top-dressing for wheat, or to plough under for that crop, from personal observation I am satisfied it is excellent. I will now turn to some experiments on turnips.

On the 15th of June, 1841, having measured out 6 acres of land, I had on each acre one of the following manures spread at the under-mentioned rates; on the following day they were all ploughed in and the turnips sown on flat work:—

				Cwt. st. lbs.			
No. 1. 15 bush. of bones, full cost	2	12	6, produced	11	4	3	of bulb.
				1	1	6½	of top.
				<hr/>			
12				5	9½	per square chain.	
<hr/>							
2. 10 loads of bullock manure . . . do.	2	10	0 do.	14	5	5	of bulb.
				1	4	2½	of top.
				<hr/>			
16				1	7½	per square chain.	
<hr/>							
3. 15 cwt. of animalized carbon do.	2	12	6 do.	10	6	6	of bulb.
				1	3	4	of top.
				<hr/>			
12				1	10	per square chain.	
<hr/>							

No. 4. 50 bush. of salt and lime . . . full cost	£.	s.	d.	0, produced	Cwt. st. lbs.			of bulb. of top.
					5	4	1	
					0	7	10	
					6	3	11	per square chain.
5. 20 sacks black-hole malt screenings . . do.	3	3	4	do.	11	6	7	of bulb.
					1	5	8½	of top.
					13	4	1½	per square chain.
6. Soil simple do.	10	0	4	of bulb.	10	0	4	of bulb.
					1	5	0	of top.
					11	5	4	per square chain.

The frost setting in early, I was not able to weigh these turnips till the early part of the following February—the most proper time I take to be the middle of December, as the turnip has then acquired its full growth and has lost its superfluous leaves: when weighed the turnips were carefully drawn and the mould well knocked off, the fibrous roots and tops were then carefully cut off, and weighed as shown above.

The turnips were sown on the flat and put in thus:—two ploughs to each acre, one with and the other without a small drill attached, thus drilling every alternate furrow, and depositing the seed in the earth as soon as it leaves the mould-board, or, as we call them in Norfolk, the plats; immediately after the land is rolled and harrowed—this mode I always pursue—consequently my rows are from 26 to 30 inches apart, and the plants in the rows I have left at from 14 to 18 inches apart; and from my slight experience this is not too much room.

The turnips on Nos. 2 and 5 were the first by two or three days to come to the hoe, while those on No. 4 were the last by some three or four days: the above results show a loss when compared with No. 6, to a considerable amount; but I ought to say No. 6 lay under a warm fence, and that although the several acres lay contiguously, yet each would be farther into the field, and therefore more exposed.

The turnips were as nearly as possible eaten off in equal quantities on each acre by sheep, and the barley sown in the early part of April; at its first coming up there was no perceptible difference, but after a short time, it being very dry weather, on examining, a difference could be discovered, Nos. 3 and 4 not looking so well as the rest; but about this time some kindly showers coming, 3 and 4 so far recovered and overtook the rest, that at harvest there was so little apparent difference, I did not think it worth keeping them separate; the land is laid down with red and white clover and rye-grass, and at this time, Feb. 22nd, the clover on Nos. 1 and 2 are looking somewhat bolder in the leaf, and better in the set, but no very marked difference, and so early in the spring one must not judge.

Last summer I again tried some experiments on turnips, which were treated in every way in precisely the same manner as described in the previous year's experiments—with regard to the cultivation—and first, I will give the difference between the purple-top swede and skirvings, grown in the same field on alternate ridges; they were weighed on the 13th of last December, and I had

Of skirvings	Tons cwt. st. lbs.				of bulb.
	1	4	0	1½	
	0	1	4	5	
					of top.
	1	5	4	6½	per square chain, or 12 15 4 9 per acre.

Purple-top	Tons cwt. st. lbs.				of bulb.
	0	18	4	5	
	0	2	1	6½	
					of top.
	1	0	5	11½	per square chain, or 10 7 2 3 per acre.

Or, Tons 2 8 2 6 in favour of skirving.

These turnips were sown the early part of last June, and the land all manured alike, at the rate of 10 loads of decomposed bullock-yard manure per acre.

June 23rd, 1842.—Turnips were sown on the following manures:—

No. 1. 20 bush. of bones, full cost 3 <i>l.</i> per acre, produced	Tons cwt. st. lbs.				of bulb.
	0	17	1	10	
	0	3	1	1	
					of top.
	per square chain				Tons cwt. st. lbs.
	1	0	2	11	or, 10 3 3 12 per acre.
2. 12 tons of horse-dung fresh from the bin, do. 3 <i>l.</i> per acre, produced	Tons cwt. st. lbs.				of bulb.
	1	1	5	6	
	0	3	0	5½	
					of top.
	per square chain				or, 12 7 2 3 per acre.
	1	4	5	11½	
3. 15 tons of fish-mould, do. 3 <i>l.</i> per acre, produced	Tons cwt. st. lbs.				of bulb.
	0	16	0	1	
	0	2	3	13	
					of top.
	per square chain				or, 9 3 0 0 per acre.
	0	18	4	0	
4. 15 tons of bullock-yard dung from the compost heap, do. 3 <i>l.</i> per acre, produced	Tons cwt. st. lbs.				of bulb.
	0	16	5	7½	
	0	2	4	9½	
					of top.
	per square chain				or, 9 12 6 2 per acre.
	0	19	2	3	
5. 3½ cwt. of guano, do. 3 <i>l.</i> per acre, produced	Tons cwt. st. lbs.				of bulb.
	1	1	1	11	
	0	3	0	1½	
					of top.
	per square chain				or, 12 2 2 13 per acre.
	1	4	1	12½	
6. 10 cwt. of rape-cake, do. 3 <i>l.</i> per acre, produced	Tons cwt. st. lbs.				of bulb.
	0	14	7	8	
	0	2	7	5	
					of top.
	per square chain				or, 8 18 5 4 per acre.
	0	17	6	3	
7. 20 sacks of black-hole malt screenings, do. 3 <i>l.</i> per acre, produced	Tons cwt. st. lbs.				of bulb.
	0	15	2	8½	
	0	2	5	12½	
					of top.
	per square chain				or, 9 0 5 0 per acre.
	0	18	0	7	
8. 50 bush. of sprats, do. 3 <i>l.</i> per acre, produced	Tons cwt. st. lbs.				of bulb.
	0	17	4	6	
	0	1	5	1	
					of top.
	per square chain				or, 9 11 7 0 per acre.
	0	19	1	7	
9. Soil simple produced	Tons cwt. st. lbs.				of bulb.
	0	9	2	11	
	0	1	7	11	
					of top.
	per square chain				or, 5 13 1 10 per acre.
	0	11	2	8	

In the foregoing experiments I have not weighed the fibrous roots (as these could not be said to be edible matter), they having been *scraped* off the bulb with a knife. Nos. 2 and 5 were the first to come to the hoe by three days; the rest were much alike, except No. 9, which was always behind. Neither this nor the previous year were my swedes annoyed to any extent by either fly or canker, while my white turnips were very much eaten off; but owing to very favourable weather, they overgrew the damage, and I had, upon the whole, a fair crop.

I have hitherto grown my turnips on the flat, but from a close observation of the ridge-system on my neighbours' farms, I am quite prepared another year to adopt it.

I think the result of the experiments on the present crop of turnips has fully compensated for all trouble I have been at in personally superintending all my experiments, which, as you may judge, have taken no small time; but as I think it every man's business who tries experiments, to give them, as I beg the above may be, to the proper authorities to judge of their fitness to be submitted to public inspection, so I also consider it to be equally their business to give the same their full personal superintendence, as then, and then only, can they vouch for their accuracy, and the agricultural world may then rely on their testimony.

Your very obedient servant,

FRANCIS CLOWES.

Hemsley, Feb. 24th, 1843.

Nov 1843

XXI.—*On the Agricultural Improvements of Lincolnshire.*

By PH. PUSEY, M.P.

ON a sunny morning in November, 1842, Mr. Handley having undertaken to show me Lincolnshire farming, we passed through Sleaford on our road to Lincoln, and soon entered upon a high but level tract, presenting a cultivated exuberance such as I had never seen before. Farm succeeded farm, each appearing to be cultivated by the owner for example—not, as was really the case, by a tenant for profit; and so for miles we passed on through fields of turnips without a blank or a weed, on which thousands after thousands of long-woolled sheep were feeding in netted folds; and so large as well as regular were the turnips in the narrow rows, that the lower halves which remained in the ground, when the upper part had been consumed, seemed to pave these sheep-folds. Every stubble-field was clean and bright; all the hedges kept low, and neatly trimmed; every farm-house well built, with spacious courts, and surrounded by such rows of high, long, saddle-backed ricks, as showed that the land did not forget to return in August what it had received from the fold in December, since the number of these farm-houses, which might always be seen at one view, proved that the size of the farms would not account for the extent of the rick-yards. Yet this land, so loaded with roots and with corn, showed no mark of natural fertility. On the contrary, it is a fawn-coloured sand about 6 inches deep, lying on a dry, thirsty, walling-stone. At length, as we journeyed on, Mr. Handley pointed out to me, standing by the side of the road, a column 70 feet high. It was a land-lighthouse, built no longer since than the middle of the last century, as a nightly guide for travellers over the dreary waste, which still retains the name of Lincoln Heath, but is now converted into a pattern of farming. This Dunston Pillar, lighted no longer time back for so singular a purpose, did appear to me a striking witness of the spirit and industry which in our own days have reared the thriving homesteads around it, and spread a mantle of teeming vegetation to its very base; and it was certainly surprising to discover at once the finest farming I had ever seen, and the only land-light-house that was ever raised. Now that the pillar has ceased to cheer the wayfarer, it may serve not only as a monument of past exertions, but as a beacon to encourage other landowners in converting their dreary moors into similar scenes of thriving industry; within living memory it was by no means useless, for Lincoln Heath was not only without culture, but without even a road. When the late Lady Robert Manners wished to visit Lincoln from her residence at Bloxholm, a groom was sent forward previously, who examined some track, and returned to report

one that was found practicable. Another family from Blankney was lost on this heath twice in one night, in returning from a ball at Lincoln, and was obliged to remain upon the waste until morning.

Passing Dunston Pillar, the road continues due north for 4 miles along the level hill-top, through the same beautiful farms, until it dips to cross the narrow breach or valley in which Lincoln city is placed, and through which the western streams find their way to the sea, but immediately rising, passes by the lofty cathedral through a Roman arch, and stretches along the ancient Roman way (Ermine Street) for nearly 20 miles, in a perfectly straight line northwards, upon North Lincoln Heath, over the same shallow sandy soil, but among the same neat enclosures, heavy turnip-crops, numerous flocks, spacious farm-buildings, surrounded by the same lofty and crowded corn-ricks. Thus, in travelling due north for 40 miles from Sleaford to Brigg, you traverse the raised platform of the South and North Heath, as may be seen by reference to Arthur Young's map; and during the whole time you pass through the best farming upon very moderate land, recently enclosed, as the fences themselves show; and, what struck me particularly, you not only see generally very high farming, but you see in 40 miles hardly any bad farming—scarcely two or three slovenly fields. The standard of cultivation is evidently very high, and to raise this standard is of course the great means of improving the farming of any district.

During the whole day we saw to our right, on the horizon, a high range of hills stretching parallel to the heath from south to north. These were the wolds of Lincolnshire, being a continuation of the chalk-hills, and it was to the northern extremity of this range that we crossed; and here, on a subsequent day, in looking over the farm of Mr. Uppleby and Mr. Graburn, at Wootton, and the farms of Lord Yarborough, constituting alone 30,000 acres, I found on the chalk also the same peculiar features of high farming as upon the opposite range of the heath; again also it was in every farmer's mouth that this vast tract of hill had been redeemed, like the Heath, from nearly equal desolation within living memory, and they had certainly been brought to a state of which, having always lived upon chalk-hills or near them, I could not but see the superiority. Here, then, there is a still larger range, estimated at 230,000 acres (nearly the extent of Bedfordshire), added in our own times to the corn-land of England.

It being the wish of our President that in each English county an inquiry should be made into the present state of its farming, compared with the Reports made to the Board of Agriculture during the war, in the hope of fulfilling this object I have twice

returned into Lincolnshire; and in order to be assured of not having ignorantly over-estimated the excellence of Lincolnshire farming, have carefully examined, during the last autumn, Northumberland and the south of Scotland.

It is not until you reach the further part of Northumberland that superior farming is found. There indeed around Belford you find it excellent, and on the land of Lord Grey and of Greenwich Hospital;* again too, in following the banks of the Till, down to the Tweed: yet even between these two fine districts a moorland tract must be crossed, neglected indeed, but not barren. So again in Scotland, 30 miles beyond Berwick, arriving at Dunbar you find, along the sea-coast, some of the famous farms of East Lothian. It is an extraordinary soil, for which the tenants, farming admirably, pay the well-known rents of 4*l.* or 5*l.* the acre, which some suppose to be the common rents of East Lothian. But ride two or three miles only inland, and you find, first, land well farmed at 2*l.* an acre; then land at 1*l.* per acre—some of it very ill farmed, foul, and out of condition; then the Lammermoor Hills, which are not farmed at all, but are in the same state as Lincoln Heath when the Dunston beacon was lighted nightly. Onwards again to Edinburgh, for 30 miles through the Lothians, you will see good land most excellently farmed, but sometimes also moderate land in a very slovenly state. If from thence you travel along the mail-coach road to Carlisle, on losing sight of Edinburgh Castle, you pass for 70 miles through the heart of South Scotland, over moors covered with a rank grass, which shows that they might bear something better, or among scanty corn-crops, which prove that nature has been little assisted by art. I cannot therefore place the general farming of southern Scotland or of Northumberland on a level with the farming of our southern counties, such as Buckinghamshire, but rather with that of North Devon; nor the general farming of East Lothian on a level with the general farming of Lincolnshire; nor the best farming of East Lothian on a level with the best farming of Lincolnshire, because it is the best land only of East Lothian on which such noble examples of farming are given, while in Lincolnshire the barren heath and wold have been taught nearly equal luxuriance.

Being thus satisfied, by a journey in the north of our island, that the discovery which I owed to Mr. Handley last year was not imaginary, but that Lincolnshire affords a very high example of farming, I had wished to lay before our Society, in detail, the various modes of management by which that excellence has been attained, but I have not enough mastered the subject. As the

* I may mention also the farm of Mr. Nairn at Warne Mills, near Belford, and that of Mr. Jobson, of Chillingham.

fullest description of a system, however, would not enable a farmer to follow that system, which he must see before he can imitate, and as my own experience had led me to the opinion expressed by Sir Robert Peel at the Lichfield meeting, that the young farmer, like the German craftsman, should enlarge his views by travelling in well-farmed districts, I will shortly state what are the objects of agricultural interest which Lincolnshire presents to such a visitor, attempting also to trace the history of its former and its recent improvements.

This great county is marked by the two ranges of hill, the heath and the wold, stretching side by side from south to north, separated by a wide level plain, which widens southwards into a district of fen containing about 350,000 acres, and forming part of the great morass that extended formerly, for 70 miles, from Cambridge to Lincoln, and was inhabited, as Camden tells us, in Elizabeth's time, by fenmen,—“a kind of people, according to the nature of the place where they dwell, who, walking high upon stilts, apply their minds to grazing, fishing, or fowling. The whole region,” he adds, “in the winter, and sometimes most parts of the year, is overflowed by the rivers; but again, when their streams are retired, it is so plenteous of a certain fat grass and full hay, which they call ‘Lid,’ that when they have mowed down as much of the better as will serve their turns, they set fire on the rest in November, at which time a man may see this fenny and moist tract on a light, flaming fire all over everywhere, and wonder thereat.” Soon after the writing of this account, great efforts were made, amid much opposition from the fenmen, to redeem the Lincolnshire fens by cutting new courses for the rivers, and digging main-drains (or canals rather they should be called for their width), such as the North and South Forty-foot; but though the body of stagnant water was greatly reduced, still it was not subdued, so that the fen-land was worth little even when George III. came to the throne: I mean the true fen-land in the interior: the ground rises towards the sea, which has thrown down upon it an excellent soil of fine sand and mud. Then, however, as the main water-courses, after the labour of two centuries, were still insufficient for delivering the waters into the sea, different districts began to seek their own remedy by surrounding themselves with embankments, which excluded the rising floods; while the rain which fell within these embankments, or down-fall water as it is called, was pumped up by windmills into these chief rivers and cuts.

Mr. Young's Report, which was made soon afterwards, in 1799, gives us some insight into the former as well as into the improved state of the fens thus embanked. “In that long reach of fen,” he says, “which extends from Tattershall to Lincoln, a great improve-

ment by embanking and draining has been ten years effecting. This is a vast work, which in the whole has drained, enclosed, built, and cultivated between 20 and 30 square miles of country. Its produce before was very small; letting for not more than 1s. 6d. an acre, but now from 11s. to 17s. an acre." Of another fen, Mr. Young says,—“Deeping Fen, which extends most of the 11 miles from that town to Spalding, is another capital improvement by draining. Twenty years ago the lands sold for about 3l. an acre; some was then let at 7s. or 8s. an acre, and a great deal more was in such a state that nobody would rent it: now it is in general worth 20s. an acre, and sells for 20l. an acre.” After mentioning other operations, he says,—“These, when carried to such an extent, are great works, and reflect the highest credit on the good sense and energy of the proprietors. Without going back to very remote periods, there cannot have been less than 150,000 acres drained and improved, on an average, from 5s. an acre to 25s.” Still, however much the last generation may have exerted themselves in these marshes, there remained enough to be done by our own; for Mr. Stone, in the year following the Report to the Board of Agriculture, writes thus:—“There are upwards of 300,000 acres at this time (1800) in Lincolnshire suffering at least, on an average, 300,000l. a-year for want of an efficient drainage, which might be carried into effect for one or two years’ improved value; and upon the borders of the county nearly the same quantity, connected with it, capable of the same improvement by similar means.” This statement was certainly well calculated to stimulate the men of Lincolnshire, and I believe that it has been well responded to by them in the forty years which have since passed. I cannot say to what extent, but must mention some of the leading improvements. The first attack was made upon a tract of 40,000 acres, containing the Wildmoor, the West and East Fens; the last of which had been thus described by Mr. Young:—“Sir Joseph Banks had the goodness to order a boat and accompanied me into the heart of this fen, which in this wet season had the appearance of a chain of lakes, bordered by great crops of reed. It is in general from 3 to 4 feet deep in water, and in one place, a channel between two lakes, 5 to 6; the bottom a blue clay under a loose black mud, 2 to 2½ feet deep.” The description was certainly not very inviting, but these difficulties were overcome by the late Mr. Rennie; the water was drawn off, the loose black mud settled down into fertile soil, the boat disappeared, the plough took its place; and, though the expenses had been estimated at 400,000l., or 10l. an acre, such was the land produced, that, after being pared and burnt, it yielded two or even three crops of oats in succession, of not less than 10 quarters an acre, and its value was rated at 2,000,000l.,

leaving a profit of 1,600,000*l.* to the proprietors. It was in this work that Mr. Rennie established the principle of separating the downfall from the upland waters, which may be thus explained. The whole district is so nearly on a level with the sea, that when the tide is up, there is not fall enough in the drains, or, as I would rather term them, 'canals, to carry the water seawards : hence their mouths are furnished with gates, which, opening from within, allow the drainage water to pass when the sea is low, but are closed by the rising tide. Mr. Rennie, however, observed that these fens were drowned not only by the rain which fell upon them, but also by the surplus of the rain falling on a large tract of higher ground, which flowed down upon them ; and it occurred to him that if, by a catchwater drain cut round the base of the rising slope along the whole margin of the fen, he could intercept these upland waters, they might be carried across the fen by a separate channel, and having a greater fall would discharge themselves in a higher state of the tide ; so that the lowlands being henceforth encumbered with their own share of rain only, this *down-fall* water would more easily be discharged while their sea-gates could be left open. Another recent improvement has been the general use of steam, instead of wind, for pumping the water out of embanked districts. Justly as Mr. Young had praised what had been done in Deeping Fen, this wide tract, while dependent on wind for its emersion, was sometimes reduced, we are told, in calm weather to a deplorable state. These 30,000 acres, however, are now entirely emancipated by two steam-engines—one of forty, the other of sixty-horse power—set up at Podes-hole. These drive a large water-wheel, which, acting not by but against the fall of the water, forces it upwards into the main channel that overrides the district, and so this great fen is dried at all seasons. A steam-engine, however, cannot always be set up, for while it frees its own it of course swells the flood which drowns other districts. But another field of improvement has been entered on, which, if carried to its full extent, will render embankment unnecessary, and also pumping, whether by wind or by steam, keeping the rivers always below the level of the adjacent lands—the improvement of their outfalls into the sea. All these fen-rivers fall into the great bay called the Wash, shallow and full of shifting mud-banks, through which at low tide they wind their shifting course into deep water. At the mouth of the Welland this difficulty will be overcome by carrying the river itself out to sea. Here, as Dr. Buckland informs me, no wall is built, but two rows of bush-faggots are laid for perhaps 50 yards in advance on the mud at low water on each side of the mouth. After a few tides these faggot-heaps are found full of a substance called warp, a mixture of fine sand and mud, which renders them in some degree

solid. Another tier of faggots is then laid upon the first, and is again embodied with them by the warp. Thus the growing embankment at last rises above high-water level, and the Welland, being now confined by its new banks, digs itself out a new channel through the yielding bottom. A fresh advance of faggots is then made, and a similar addition to the double embankment ensues. In this way has the engineer advanced 3 miles into the sea, compelling the waves to cement the frail materials of their own subjugation, and by these means all the rivers of the Great Wash might be carried forward to a common outfall, so that the fen district would acquire a perfect and natural drainage. Nor is the benefit of these outfalls confined to drainage and navigation, for when the new river-banks are completed they are connected with the shore by cross embankments, and the portions of sea thus cut off are gradually filled up by warp, and become excellent land. Before we leave the south fens of Lincolnshire, I must mention a great work about to be undertaken in the neighbouring county of Cambridge, a new main channel or river, passing for more than 30 miles upwards from Lynn, through the heart of the Bedford Level, to Whittlesea Meer, in Huntingdonshire, one of the two only lakes which, as we learnt in our books of geography, belonged to the south of England. Ramsey Meer, its Cambridgeshire neighbour, has already disappeared, and fine crops of wheat are growing upon the bottom; and I rejoice to hear that, by means of Mr. Walker's new cut, Whittlesea Meer will shortly be likewise blotted out of our maps.

Leaving now the south of Lincolnshire, we find that the great central valley, as it inclines towards the north also, soon becomes a fen district; and we find too another great work of drainage—the new Ancholme River, cut towards the end of the last century, a wide canal running in a straight line for 20 miles to the Humber, laying dry 17,000 acres. Of this level Arthur Young says, “Before the draining it was worth but from 1*s.* to 3*s.* 6*d.*, now it is from 10*s.* to 30*s.*” These redeemed meadows, or carrs, as they are called, I found to consist of an unctuous peat, which derives its richness from a mixture of sediment thrown down by the former floods while the peat was deposited.

There is still one other lowland tract of which, having visited it in the summer, I wish to say a few words. It lies on the west of the western hills, partly in Yorkshire, the level of Hatfield Chase. When you ride across this vast plain, through endless corn-fields, with the distant uplands of Yorkshire and Lincolnshire for its opposite boundaries, you see a single hill which, rearing itself midway from the dead flat between them, was formerly an island, and is still named the Isle of Axholme. A great part of this fertile plain was once sea, as it would now be again if

its embankments were neglected, being mostly below high-water mark. In early times the island was a strong post: thus it was occupied by a Lord Mowbray, under Henry II., but was taken by the men of Lincolnshire, who attacked it in boats. It was a refuge for some of the barons after the battle of Evesham. In the time of Charles I. the waters were drawn off by a colony of Dutchmen under Vermuyden; but during the civil war, the Parliamentary committee of Lincolnshire, fearing an attack from the Yorkshire Royalists, cut the dyke, and again interposed the sea between the two hostile counties. This great level is now generally well drained by a system of canals and side-vents, but the farmers of Axholme have not forgotten that their forefathers attended Doncaster market in boats. Having mentioned these farmers, I ought not to omit what Young says of their condition:—

“As to property, I know nothing more singular than its great division in the Isle of Axholme. In most of the towns there, for it is not quite general, there is much resemblance of some rich parts of France and Flanders. The inhabitants are collected in villages and hamlets, and almost every house you see (except very poor cottages on the borders of commons) is inhabited by a farmer, the proprietor of his farm of from 4 or 5, or even fewer, to 20, 40, and more acres, scattered about the open fields, and cultivated with all those minutiae of care and anxiety by the hands of the family which are found abroad in the countries mentioned. They are very poor respecting money, but very happy respecting their mode of existence. . . . They have, generally speaking, no fallows, but an endless succession of corn, potatoes, hemp, flax, beans, &c. They do nearly all their work themselves, and are passionately fond of buying a bit of land.”

Such are some of the great Lincolnshire drainages, most imperfectly described. I will only add that the example might well be followed elsewhere. In the Bridgewater Level during last May, many thousand acres of young corn were deeply flooded; and nightly struggles took place, with discharge of fire-arms, between the labourers on one side of a dyke endeavouring to cut it through for the discharge of the waters, and those of the opposite district resisting the inundation. Whatever may have been already done, more might evidently be effected if those who possess the course of the water to the Bristol Channel could be brought into concert with their less fortunate neighbours. There are numberless districts also, throughout England, where the ditches are now stagnant throughout the winter, and all improvement of the land thus prevented—the remedy lying in some inexpensive cutting of a paltry brook, on which neighbouring landowners, however, cannot agree: whence these sound lands are drowned for half the year, though Deeping Fen is kept dry and firm by its steam-engines. We ought to act at last on the declaration of King

James, that he would not suffer any longer the land to be abandoned to the will of the waters.

But before leaving the neighbourhood of Axholme I must mention the practice of warping, known in no other part of the world. We have seen that in the southern part of the county the sea casts down a fine mud or silt, which obstructs the mouths of the rivers, and fills up any shallows that are partially enclosed from the waves. The Humber, where it mixes with the sea, contains in dry seasons so much of this silt or warp, that if a glass tube be filled with it to the height of 15 inches, an inch of sediment, we are told, may sometimes be seen at the bottom. About seventy years ago it occurred to a landowner at Rawcliffe, that if this water were laid upon his land the sediment would be secured; and his success established the system, of which I saw an example near Axholme. The water is brought up from the Humber by a canal, chiefly made for the purpose, the level of which at high tide is much above the adjoining land. Two adjoining fields, of perhaps 50 acres, had been surrounded by a temporary bank about 6 feet high, which confined the water when admitted from the canal by a cut through its side. The tide, when I saw these fields, was retiring, and they had the appearance of a muddy harbour covered partly with water, partly with slime, but in part showing the original herbage which was not yet buried. This marine appearance was striking in an inland field, 10 miles distant from the upper end of the Humber; still it was only the commencement of the operation, for the object of warping is not to improve the existing soil by a slight covering of mud, but to create an entirely new soil. As Mr. Young observes,—

“What the land is, intended to be warped, is not of the smallest consequence—a bog, clay, sand, or a barn-floor, all one—as the warp raises it in one summer from 6 to 16 inches thick, and in hollows or low places 2, 3, or 4 feet, so as to leave the whole piece level. Thus a soil of any depth you please is formed, which consists of mud of vast fertility, though containing not much besides sand, but a sand unique.”

The owners of the canal charged in this case 15*l.* per acre for the use of the water, but the benefit corresponds with the price; for this new soil will sometimes bear wheat and beans alternately, with an occasional naked fallow, for twelve or thirteen years without any manure; and the crop, Mr. Young says, should be 30 or 36 bushels of wheat, 60 of beans. An acre was once measured to produce 99 bushels of beans. Yet, even for such an improvement, there is great enterprise in the landowner who expends 15*l.* per acre; and great confidence in that landowner's spirit must also have been entertained by the adventurers who risked their capital on a canal with the hope of selling the water, or rather the future land, at such a price. This practice is now imi-

tated in the same neighbourhood, by a process which, until it was shown me by Mr. Childers, I could not believe to be practicable. The site is over the borders in Yorkshire, but the operation ought to be put on our Society's records. Mr. Gossip having purchased, about Hatfield Chase, 4000 acres of worthless, deep, quaking bog, devoid of any mineral matter, for a trifling sum, found that near it, in the bed of a river which had been abandoned when a straight cut was made for draining the level, he possessed a deep and extensive bed of warp with which the deserted water-course had been silted up during the temporary return of the waters when the works were destroyed; and he conceived the plan of spreading this deposit over his barren waste. On visiting the spot we found a quarry of several acres excavated to the depth of 30 feet in the bed of warp—the loaded earth-waggon being drawn up an inclined plane by a steam-engine fixed at the quarry's mouth, travelling thence along a railroad over the moor, and depositing their loads, in a regular coat 8 inches deep, upon its surface. When they had thus covered the bog on each side of the railway, as far as it reached, an enormous but manageable machine proceeds to the extremity, takes up each piece of the railway as an elephant might with his trunk, and deposits them in a fresh line upon the uncovered morass. Thus you see the thick sheet of firm and fruitful soil steadily spreading over the hopeless quagmire; and you pass, at a single step, from the Bog of Allen to the Vale of Aylesbury or of Whitehorse; for you not only see oats sown in March upon land made in February, but beans, the surest sign of a good staple, upon the new soil of the former year.

The expense is about 15*l.* per acre, the first cost of the land was 3*l.*; and it is now well worth 25*s.* to rent. This is not, however, an example which can be followed; for scarcely could such a mine of soil, capable of supporting vegetation at once, be worked elsewhere to such a depth, though Mr. Everett informed me of one such deposit found in the United States. Nor, indeed, could water-warping itself be generally adopted, though along the banks of the Trent, Air, Dun, and other streams of the Humber, it has been followed up with great spirit since Mr. Young's time, to the extent of 50,000 acres, if I am rightly informed; and the tide has been thus set to work upon land near Gainsborough, which is 20 miles up the Trent, and 60 miles distant from the open sea. It is by simpler processes, however, that farmers generally must be contented to work; and in the fens of southern Lincolnshire may be seen an excellent example of changing the soil, not indeed by laying down another upon it, but by tempering the surface anew with a material which nature has hidden beneath it. I mean the claying of peat, which has been described in our Journal, but must not be omitted from the great improvements of Lincoln-

shire; its effect may be conveniently seen in the Digby, the Dorrington, and other Fens, not far north of Sleaford. Mr. Cooke, of Digby, has given a plain and practical account* of the process to this effect. The peat of that neighbourhood is poor and hollow, producing naturally not more than 5 quarters of light oats, worth 20s.; and 20 bushels of very light wheat, fit only for seed, worth at the time 50s. per quarter. Beneath this peat, however, is found, at a depth of 4 feet, a blue soapy clay. Trenches, then, are dug down to this clay, at the interval of 11 yards across the field, and a large quantity of the clay thrown out from their bottom upon the surface, after which they are filled in. The operation costs only 54s. per acre; but henceforth the land produces 30 bushels of good wheat, worth more by 8s. per quarter, so that very bad land is changed into very good land for less than 3*l*. This cheap transformation of soil has been carried out with great spirit in the Lincolnshire fens, since Mr. Young's Report; and as he does not speak of the process, the whole credit of it is due, I suppose, to the present generation of farmers. Another transformation of the same character has been executed, with equal vigour, by the employment of chalk; and as this process takes us out of the marshes where we have so long lingered, and leads us upon the high wolds, I will now endeavour, in discharge of my task, to trace the farming history of these hills, examining what had been done by the last generation when Mr. Young wrote, and how much the farmers of this century have improved upon what they had received from their predecessors.

Of this high range, equal in extent, as I have said, to the county of Bedford, and now a pattern of neat fences and good farming, Young says, in 1799, "Forty years ago it was all warren for 30 miles, from Spilsby to beyond Caistor" (indeed the present Lord Yarborough remembers when, in riding from Spilsby, the southern point of the wolds, to his own seat at Brocklesby, many miles beyond Caistor, and in sight of the Humber, he met but two fences); "and, by means of turnips and seeds, there are now at least twenty sheep kept to one there before." Having visited these hills in 1760, Mr. Young is an unimpeachable witness as to their former condition. Great improvements, it appears, had taken place between his two visits, for elsewhere he says,—

"Remembering as I do this county, about forty years ago, no circumstance in it surprised me more than the astonishing change effected in respect to the turnip crop. At that time there was scarcely a turnip to be seen where now thousands of acres flourish; and the few sown in the whole county were unhoed, except by here and there a gentleman. This has been a most meritorious progress, closely attending *that first of improvements, enclosing heaths and wastes*. The crop is not yet perfect

* See Journal, vol. ii., p. 406.

in the hands of all farmers ; but immense tracts are very well managed, and, by many persons, in as capital a style as any in Norfolk."

After all these improvements, however, there still remained many wide wastes, as we find in gathering the state of these hills from the scattered remarks of Mr. Young, in 1799. Thus he says in one place, "From Louth to Caistor, 18 miles, 10 of it are warrens, chiefly silvers" (that is, the rabbits); "rent 2*s.* an acre."

Again,—

"The wold land about Louth, to the west and south-west, is good ; very generally a dry, friable, loamy sand, on a flinty loam, and, under that, chalk everywhere : this is the soil on the warrens between Gayton and Tathwell, which I passed, and *I was much hurt at seeing such land so applied.* I exclaimed to Mr. Clough on seeing it : he replied, '*Oh, it is good for nothing but rabbits : what would you do with such poor land, 2 or 3 miles from the farms ?*' When men have long been accustomed to see rabbits on such deserts, and hear only that they are good for nothing else, they come to think with their neighbours, let the absurdity be what it may."

Turning from the south of Louth towards the north, Mr. Young says again,—

"The tract of wold north of Louth, by Elkington, Ormesby, Wyham, Binbrook, Swinhop, Thoresby, &c., exhibits a great variety of excellent soil—all calcareous, friable, sandy loams, on a chalk bottom—dry enough to feed turnips, and much good enough for wheat. The red chalks are particularly good, being almost without exception excellent for turnips and barley. At Thoresby Warren the vales are red, and nettles are among the spontaneous growth. Nettles and rabbits together !"

These warrens have all disappeared ; but let it not be imagined that we have no similar waste of land in our own days. Often, I must say, on the shooting-moors of Somersetshire and Derbyshire, and Scotland, have I also wondered at seeing such land so applied, and passing among bright fern that tufted the strong heather, could have exclaimed, "Fern and blackcocks together !" But on those moors I will venture to make a few remarks presently, and will only quote one more passage, which I met with in Mr. Young's Report, describing the Lincolnshire chalk-hills in 1799, towards their northern extremity :—

"Near Brocklesby, &c., there are large tracts of excellent land under gorse ; and at Caburn and Swallow I passed through the same for miles. It is a beautiful plant to a fox-hunter. Lord Yarborough keeps a pack of hounds : if he has a fall, I hope it will be into a furze-bush ; he is too good to be hurt much, but a decent pricking might be beneficial to the country."

I must say that when Mr. Handley pointed out to me this estate in 1842, then entirely unknown, its fine farm-buildings, on which 150,000*l.* have been expended, surrounded by lofty ricks,

its 30,000 acres of good turnip-land, divided by clipped hedges of thorn, where Mr. Young saw miles of gorse, and of course thousands of rabbits, I thought I had made the discovery of a domain equal in the spirit, magnitude, and rapidity of its improvement to the well-known estate of Holkham; and, having seen it again last October—though, in consequence I suppose of the weather, the turnips did not look so well as before—I think so still. Mr. Young was informed by the late Lord Yarborough that his wold-land then let for 5s. an acre. I may state that, tithe-free, it is now worth five times that amount: and great as is the change on the Brocklesby estate, it is not greater than the general change of these chalk-hills. The first step was of course grubbing the furze, paring and burning the rough peaty grass; the latter costing a guinea per acre. Then there was brought a heavy dressing of chalk, 80 cubic yards to the acre, costing at the time 66s.; last followed 60 bushels of bones, for bones were cheap in those days, and a bushel cost but 1s. 3d., making another item of nearly 4l. I am told that the wolds have been chalked twice over; and that, without chalking, the turnips are destroyed by the excrescence called “fingers and toes:” but even the first outlay of the tenant amounted to more than 8l. per acre—a great sum for the individual farmer, and a very large amount upon the acreage of the whole district. And here, though I would by no means argue against the granting of leases, but think, on the contrary, that when a tenant is ready to sink his money upon a farm, he is entitled to that security, if he desire it, I must state in fairness that this large sum of 8l. per acre, or 8000l. on a farm of 1000 acres, has been expended on the farms at Brocklesby (according to the practice of Lincolnshire) only through well-merited confidence in the owner: and I must also mention, that whereas in East Lothian, where leases run in general for nineteen years, the lease and the tenancy are often ended together; here, on the other hand, the farm, though on a yearly tenure, passes, almost as a matter of course, from father to son; in one case, when a farmer dying left a son three years old only, two neighbouring tenants undertook, and were allowed by the landlord, to manage the farm for the infant, in trust until his majority. Nor has the spirited outlay on the part of the farmers been without its return. The parish of Limber, 4000 acres, was formerly let to four tenants, at 125l. each, or 2s. 6d. an acre, and all four became bankrupts. It has been enclosed, is now well farmed, excepting what has been planted, and at the present rent the tenants are doing well. In some instances considerable fortunes even have been made. I may cite the case of Mr. R. Dawson, well known in the county, who occupied the entire parish of Withcall, 2600 acres of ploughed ground, with one barn at the homestead. He was one of the

first who ventured a heavy outlay upon his land: his yearly bill for bones alone was from 1500*l.* to 1800*l.* A friend, who staid at his house for three days about 1835, tells me that he thought Mr. Dawson's management the perfection of farming; and you might see a single field of 350 acres in turnips. He died a few years since, and left a large fortune. Such instances, of course, are uncommon; but I believe that what Arthur Young observes, in his 'Six Months' Tour,' is perfectly true,—namely, that large fortunes can only be made in farming by the spirited cultivation of land which had been previously ill-farmed, or of absolute waste. The three points of ordinary chalk-farming in Lincolnshire are, first, thorough chalking of the land, repeated when the first covering of chalk is worn out; secondly, boning the whole of the turnip crop, at 12 or 16 bushels per acre, to which farmers are often bound by their agreements; thirdly, keeping always in winter a large number of horned cattle in the yards, which, being fed on oil-cake, convert the straw into excellent dung. This practice, though almost unknown in the south of England, is common in the eastern counties and in the Lothians, but with an important difference. In the eastern counties the beasts receive turnips drawn from the land, and in the Lothians are fed mainly on turnips, which in the North growing more slowly are more nutritious than in the South. But on the light lands of Lincolnshire the farmers say that their weak soil cannot spare the turnips—that is, cannot spare the manure which the sheep would make from those roots upon the land where they grow. Instead, therefore, of drawing home their turnips, they purchase large quantities of oil-cake (80 tons perhaps, upon a large farm costing 600*l.*), by the aid of which their beasts thrive on the straw, and the manure is at the same time enriched. This peculiar practice appears to me so important that I inquired into its details. The cattle are bought in November, and kept loose in separate yards, 10 or 15 together; and such is the abundance of straw, that I have seen a gate hung between two of these yards nearly 3 feet high, that it might have room for opening at the close of the winter. The number of beasts thus wintered upon a farm of 1000 acres varies from 70 to 100, or more. There are two kinds of beasts purchased, and hence two kinds of management. Generally young beasts, two year olds, are bought in for about 8*l.* a head—no small outlay of capital in addition to the ordinary stock of a farm; and, without of course attempting to fatten them, the farmers give to each about four pounds of linseed cake daily. They are thus kept growing, perhaps slightly improving, through the winter; and when they are sold in the spring, the increase in their value is expected just to clear the cost of the cake they have eaten, though it has been also stated to me that if the beasts repay half the cake

they have eaten the farmer still thinks himself well rewarded. Another method is to buy in three-year-old beasts, to give them first eight pounds, then twelve pounds, at last as much as sixteen pounds daily; so that when these beasts are sold out in the spring, also, they are three-quarters fat, and ready to be finished elsewhere at grass. These, however, like the others, only pay I suppose at most the bill for oil-cake, and are what the Lincolnshire farmers call them, machines for converting the straw into dung. But it is oil-cake dung, not the litter trampled by a few horses or pigs, and turned by the rains into the semblance of dung, which we frequently see in the South: and as the third horse is cast off from the plough upon our light land, southern dung, if it can so be called, will become weaker. We feed our sheep, indeed, sometimes more rapidly, and so recompense our land in some degree; but in the manufacture of dung I must admit that we are distanced. It also strikes me that this Lincolnshire process might be applied to a kind of soil for which so little new help has yet been struck out; I mean the cold, heavy, almost hopeless, clays. Drain them as we may, there are many tracts of such land on which roots cannot be grown; or if roots be forced to grow, the injury done to the land if folded by sheep, or by carting the roots away, more than counterbalances the advantage, as Mr. Handley informs me that he and other farmers have found by experience. How then is good dung to be made upon such a farm? I should say by transferring to it the Lincolnshire method. It is true that the straw is usually short and thin on such land; but I do think, and I hope the suggestion will not appear theoretical, that if on such a farm, after draining and dressing it with burnt clay, the bulk of straw were increased, by applying guano, for instance, to the oat-crop;* and if that straw thus increased were used by cattle with oil-cake,† a new face might be given to its cultivation. The method would then be equally important for soil which is so light that the turnips grown on it cannot be drawn without weakening the succeeding crop, and for land which is so heavy that turnips

* It is proposed to apply the guano to the oat rather than to the wheat-crop, because the slightest excess of stimulating manure applied to wheat brings the risk of mildew. Where guano has been drilled with wheat on a cold clay I have seen injury produced to the crop on the crown of the ridge, while the effect near the furrow was good. On the same farm the tenant had used guano with advantage on wheat by handsowing it in March on the parts near the furrow, and afterwards hoeing it in. The result of the guano so applied was very favourable.

† I do not mean that cattle so wintered must necessarily be kept on oil-cake. There is no doubt that the farmer might use spring-corn grown upon his own fields. Mr. Graburn informs me that the oil-cake imported into and produced last year at Hull amounted to more than 30,000 tons, which must have cost the farmers of Yorkshire, Lincolnshire, and Nottinghamshire, as much as 160,000 quarters of barley.

cannot be grown on it, or, if grown, cannot be removed without trampling it into a state of clay. There is no doubt, at all events, that the practice answers upon the wolds, where a farmer would as little think of holding his farm without sheep on his turnips, as without beasts in his yard. It is equally general upon the opposite range of Lincoln Heath, where, if the reader will now cross the great central plain of the county, we may close our survey of Lincolnshire farming.

This range, which I have already endeavoured to describe as it was shown me by Mr. Handley, had lost none of its agricultural beauty in last October; but I need not, as on the Wolds, establish by evidence its former barrenness, since of that the Dunston Pillar is still a visible witness. One passage of Mr. Young's Report in 1799 will be therefore enough:—

“The vast benefit of enclosing can, upon inferior soils, be rarely seen in a more advantageous light than upon Lincoln Heath. I found a large range which formerly was covered with heath, gorse, &c., and yielding in fact little or no produce, converted by enclosure to profitable arable farms, let on an average at 10s. an acre, and a very extensive country, *all studded with new farm-houses, barns, offices, and every appearance of thriving industry*; nor is the extent small, for these heaths extend near *seventy miles*, and the progress is so great in *twenty years* that very little remains to do. The effect of these enclosures has been very great; for while rents have risen on the heath from nothing in most instances, and next to nothing in the rest, to 8s. or 10s. an acre, the farmers are in much better circumstances, a great produce is created, cattle and sheep increased, and the poor-employed.”

This is indeed a bright picture of wide and rapid improvement drawn at the close of the last century; and Mr. Young might well say that little remained to do. But has nothing been done? Under another head of his report, “Amount of Crops,” I find the following entry:—“In the enclosures from the heath—crop of barley, three quarters; oats, four; no wheat.” And in my own note-book, taken on the same heath in the present year:—“barley, six quarters; oats, none—since they are too poor a grain for such farms; wheat, four quarters, sometimes five,”—a warning that in farming, as in other pursuits, we should not say “very little remains to do.” This latter amount of crops, too, was noted upon a farm which is thus spoken of by Mr. Young even in 1799, when the general enclosure of Lincoln Heath had been carried out; it is under the head ‘Wastes.’ “At Blankney and its vicinity Mr. Chaplin has 3000 or 4000 acres of warrens let at the highest at 3s. 6d. an acre, some at 2s.” This very land was enclosed by the present Mr. Chaplin as lately as the year 1823, a year of the lowest depression for agricultural prices and spirits, so that his undertaking was spoken of as an act of absurdity; but Mr.

Chaplin was not disturbed nor discouraged. On one of these farms which he then established at Temple Bruer, his tenant, Mr. Frankish, a practical farmer, now advanced in years, has been steadily pursuing a system of farming, so admirable that I must state the details, though its merits I fear can only be appreciated by other farmers. The soil is a yellowish sand, about 6 inches deep only, and on a dry walling-stone rock. The extent of the farm is about 700 acres, of the same light shallow soil, all under the plough. The rotation is the common four-course one—turnips, barley, clover or grass seeds, and wheat.

The peculiarity is in the number of dressings, purchased and successively applied to these crops. The ordinary number of dressings varies in other districts where this four-course system prevails. Thus on one farm of my own, the land during the four years' rotation only received a little poor dung, or rather rotten straw, at wheat-sowing. The turnips, if any turnips grew, were fed off by breeding ewes, who sometimes obtained rough hay, and who in one season, as I found, obtaining only mouldy pease-straw, had lost one-half of their sucking lambs, which they could not sustain. Such starvation of land, and far worse of animals, is, one must hope, extraordinary also. A better treatment is to give dung to some of the turnips, and to buy woollen rags for part of the wheat. A further step would be to fatten off the young sheep when they are a year old, giving them corn with their turnips; and this could not be called bad farming, if the soil had any depth or natural strength; but the farm at Temple Bruer has neither depth nor natural strength—and I will state how these two defects are supplied by its tenant beginning with the turnip-crop as the foundation. This crop is sown with 16 bushels of bones, and it is fed off upon the land by sheep receiving oil-cake, which may be regarded as a dressing for the following barley crop. In the next year, after the barley is mown, follows a dressing which will surprise many farmers. The dung of the whole year, which I saw in a vast mass, cleared out of the yard in October, enriched with oil-cake that had been purchased for sixty beasts wintered there, is laid at Christmas upon the barley stubble, for the benefit of the artificial grasses which follow. Of these grasses or seeds, as they are called (among which two pounds of parsley are sown, a common Lincolnshire practice), only one-third is made into hay and carried off, two-thirds are depastured and return again to the ground. Observing too that troughs were set out upon these seeds last October, I found on inquiry that they contained oil-cake for fattening ewes; and that this is a growing practice, the ewes receiving each a pound of cake daily. Last follows the wheat-sowing; and not content with having spread the whole of his oil-cake dung upon the seeds at the previous Christmas, or

with having fed off two-thirds of these seeds upon it in the summer, and so restored to the ground what it had brought forth, or even with having given oil-cake to his ewes in October upon it, this practical farmer buys rape-cake, which he throws on his land at the rate of 4 cwt. to the acre, when he has ploughed the ground and pressed it for wheat-sowing. Thus in the four years' course, the turnips obtain bones, purchased, the barley obtains oil-cake eaten by the sheep, purchased, the seeds obtain the dung made with oil-cake that has been purchased, and the wheat obtains two-thirds of the seeds fed on the land; oil-cake for the fatting ewes purchased, and rape-cake at its own seed-time also purchased. This repetition of dressings is, I should think, quite unexampled. The result is noble crops upon land for which a few years since the rent was paid by two rabbits an acre. The yearly outlay, indeed, on manures may well amount to a second rent; but the tenant (who occupies other farms also) is regarded as a prosperous man. Another farm of 1000 acres, enclosed at the same time by Mr. Chaplin from the same warren, is held by a tenant who last year kept 110 beasts in his straw-yard, and bought 80 tons of oil-cake. The beasts could not have cost less than 1000*l.*, nor the oil-cake less than 640*l.* This expenditure, it should be observed, is not in diminution of the investment in sheep, the ordinary stock of such land. Indeed it appeared to me, on the contrary, that the flocks of sheep were unusually numerous, and the following statement seems to bear out that impression:—A farm of 500 acres, having 125 acres of turnips, is said to winter from 10 to 12 sheep per acre, that is from 1250 to 1500 sheep. The breed, too, is the improved Lincoln, which, though very inferior to the Down sheep in quality, exceed them in weight, and consequently in their demand for food, in the proportion of five to four; and these sheep are in addition to 40 or 50 beasts in the straw-yard. Such is Lincoln Heath, lately a warren; now on a bright frosty day in December like a sheep-market. It remains only to show how far the example of Lincolnshire farmers may be imitated in other parts of the country; but first I ought to mention some points in which I think their own farming might be improved.

Their ploughs, though drawn by two horses, excepting on heavy land, where three are employed, are heavy swing-ploughs, for which the new light wheel-ploughs ought to be substituted. In some points too East Lothian has surpassed them. The Lincolnshire horses are slow; the Clydesdales quick, stout, and in higher condition. The Lincolnshire waggons are very ponderous masses of timber. In the north, light one-horse carts only are used: and here, as the question of carts or waggons is an important one, I will mention an experiment lately made at my re-

quest by three Berkshire farmers living near Farringdon. Mr. Edmunds, who has lately introduced one-horse carts, and Mr. Brookes, who employs the light Berkshire waggon, agreed to compare the quantity of wheat carried by them from two fields of similar crop, along the same kind of road, to their homesteads. The result appears in the following table :—

		Driving lads.	Time. h. m.	Distance in Furlongs.	Horses.	Acres of Wheat cleared.
Mr. Brooks	3 waggons	2	4 50	5	7	5
Mr. Edmunds	4 carts	3	5 0	4 $\frac{1}{2}$	4	9

The crop carried with waggons was a little thicker upon the land than the other, but not so much so as to make much difference in the trial. It was necessary also to try the one-horse system in the other branch of farm-carriage, the carting of dung. This was done by Mr. Harris, of Hinton. One day he led the dung with his own three-horse carts; the next day he led it to the same field with the one-horse carts of Mr. Edmunds. The strength employed was as follows :—

	Carts.	Driving lads.	Horses.
Three-horse carts	4	3	10
One-horse carts	5	4	5

Though the horses on the first day doubled those on the second in number, Mr. Harris carried nearly or quite as much dung on the second day as on the first. These two trials seem decisive in favour of one-horse carts, which are used not in the North alone but in Bedfordshire and neighbouring districts; and as a cart with a moveable harvest-rail may be bought for 13*l.*, I have now no longer any doubt that, unless on very deep land, if a farmer will part with all his waggons and heavy dung-carts, buying a complete set of light one-horse carts in their room, he will be quickly repaid by the large immediate saving in horse-keep.

Again, though the farm-buildings of Lincolnshire are excellent, I was sorry in some of the yards to see the numerous cattle standing shelterless in the midst of a snow-storm. These yards should at once be furnished with sheds, for the beast's sake and his master's. One more improvement only I will beg to suggest. After passing through north Northumberland or East Lothian, one misses in Lincolnshire the high steam-engine chimney which in those districts towers over every farm-house, and though travelling steam-threshing machines are partially used in Lincolnshire, the large farms at least should, I think, have a fixed one. A steam-engine has been already set up on Mr. Uppleby's farm at Wootton, of which his relative, Mr. Graburn, gives the following account :—

“ The disc-engine exceeds our expectation in every respect; it is

easily managed without the employment of an educated engineer, and has hitherto required no repairs. At present we thresh and winnow grain by steam, cut chaff, grind and dress corn, flatten linseed or beans, and break cake. Bones we propose breaking, and also the steaming of chaff. We have not reduced our number of horses, having undertaken our own 'marling,' or chalk leading, which is generally contracted for; but we are convinced that four horses out of eighteen will eventually be saved by the use of steam."

The disc-engine, which from its simple form is the best I believe for farmers, was put up for Mr. Uppleby by our consulting-engineer, Mr. Parkes. These improvements, if they be such, will doubtless be made by the farmers of this county, for the face of their fields shows that their minds have not been closed to inquiry. They have one advantage indeed in those fields which must not be passed over—their size, I mean—which varies from 30 to 50 acres, and their clipped hedges uninjured by trees—an advantage which will be felt by farmers from the west side of England, whose 4 or 5 acre fields are half overshadowed by trees. One farmer indeed in Devonshire lately grew, I was assured, 100 acres of wheat in fifty different fields. The profit of the trees that grow in these fences cannot compensate for the land which they injure. I have seen turnip-fields in which one-third of the crop has been spoiled by the hedgerow timber, partly through the dripping from the leaves, but in great part by the roots, whose fine threads shoot up among the turnips into the freshly-ploughed ground, and sometimes clog the harrows in the following spring. It is clear that, though the landlord's trees may be permitted to stretch their roots through his own land, when that land, poor and starved, is left on the old system of farming to its own natural efforts, they cannot be entitled to forage upon manure bought at a heavy expense by the tenant; and though the forest-like appearance of such small wooded enclosures is very beautiful, still, were the fences removed,* one-fourth might often be gained to the land,

* The improvement which may be produced by the removal of old fences is described in the following statement by Mr. Keeling, a Staffordshire farmer:—

"At the request of Lord Hatherton I send you the measurement of the two large fields at Yew-Tree Farm. The turnip-field is 65 acres; it was two years back, at the time I entered upon the farm, in eight enclosures: I have taken up 1914 yards of fences, and intend dividing it into three fields; it will take 800 yards of new fence. The field in which I was sub-soiling is 42 acres; it was in six enclosures. I took up 1264 yards of fences; if I divide this field it will take 300 yards of new fence. The land Lord Hatherton mentioned on my Deanery Farm was originally in 27 enclosures, 91 acres. I took up 4427 yards of fences; it will now lie in five fields, and will take 1016 yards of new fence, a part of which are planted.

"I really cannot say what land is gained by the different operations, but some of the fences were from three to four yards or more wide, that the plough never touched; my new fences are upon the level without ditches;

while a few trees spared give to the open farm the appearance of an arable park. In Lincolnshire, however, perhaps the opposite fault of too bare exposure should be corrected by the plantation of screens, and the piercing winds of winter and spring be thus mitigated.

It remains only to inquire how far the methods of farming, so successful on light land in Lincolnshire, are applicable to other counties; and it so happens that the Wolds of that county are but a part of the great range of chalk-hills which traverse the south of England. Now, one feature of chalk-farms in Lincolnshire is that they contain no waste ground. But on our southern chalk-hills the furze-bushes, of which we only read on the Wolds, have not disappeared. These should clearly be grubbed, and in proof that this may be done with success in the South also, I may cite a farm of 360 acres, at Kingswood, upon the Surrey chalk hills, inclosed in 1815, grubbed, pared, and burnt, the ashes ploughed in very *thinly* and chalked, as the tenant informs his landlord, Mr. Alcock, and now worth 14s. an acre. "Near Kingswood," however, Mr. Alcock states, "there are Banstead and Walton commons, together between 2000 and 3000 acres of land. I should suppose," he adds, "that their annual value is not more than 3d. or 4d. per acre, but I do not hesitate to say that if enclosed they would be worth 14s. per acre." A larger portion of uncultivated surface on our southern chalk-hills is down-land, on which the sheep feed by day, but do not remain at night, so that year by year the natural strength of this land is thus carried away to more favoured fields. All these downs a Lincolnshire farmer would bring under the plough; and though, if downs after ploughing be first sown with two or three crops of corn in succession, then left to casual grass and the sheep, their last state would be worse than their former condition, there can be no doubt, on the other hand, that if they were handled as in Lincolnshire, with artificial manure, their value as property would soon greatly increase, and that this new field of employment would much encourage the labourer. It may be said that the soil is thin on our downs; but on these Wolds soil not 5 inches deep bears excellent corn. Subject of course to exceptions, our downs, I believe, should be broken up; and a tenant should be encouraged to do so, provided he undertook by

in the whole of the old fences there were a great number of ash-trees which are all stocked up, as well as a good part of the oak, only leaving a few for ornament and shelter. I think the greatest gain in land will be from getting rid of the trees.—*Conger, Nov. 30th, 1843.*"

Mr. Keeling, it will be remarked, after the extensive clearance by which he has thrown twenty-seven fields into one field of 92 acres, subdivides it again into five fields. My own tenants do not generally wish to have more than one ploughed field on a farm. Ph. P.

agreement, as at Brocklesby, to bone the land in every rotation. Another feature of Lincolnshire farming is, that not only is the whole farm in fields, but that, however large the farm, all the fields are treated equally well: while on other parts of the chalk-hills an outlying field may be used for twenty years without any manure, because it is too distant from the yard for the carriage of dung, and lighter manures are not bought for it. The third point is, that not only are all the fields of a farm farmed by an equal standard, but that the standard of the district is a very high one. On every part of the southern chalk-hills there may be individual farms as highly manured as the Lincolnshire Wolds, but I know of no part where so heavy an outlay on manure is the universal rule of the country.

The Yorkshire wolds, I may add, have been treated almost in the same manner, and this outlay appears to answer in the hands of one Yorkshire and of two Lincolnshire farmers, who have settled upon our southern chalk-hills. A lesson from these wolds might thus be read, I should think, wherever the chalk stretches, even as far as Dorsetshire; but the example of Lincoln Heath is capable of an application far wider. In 1780 it was a tract of well-known desolation for nearly 70 miles, as Young informs us. Within twenty years nearly the whole of it was enclosed and studded with buildings; now it is a pattern of farming. Might other ranges of heath, as yet equally dreary, be rendered in the next 20 years not less cheerful or fertile? I believe that they might: and as heath-land forms a large portion of our improveable wastes, which in England amount to 4,000,000, and in Scotland to 6,000,000 of acres—as whoever recommends an improvement is bound to show the means of its execution—and as I should not presume to recommend this change without having examined many heaths for the purpose, I may be permitted to enter into some detail on the improvement of heaths.

Since it is better to speak of individual cases than to deal with a matter vaguely, I will mention first an extensive tract of heath which fills the western end of Somersetshire. These moorlands occupy a wide range of hills, or rather low mountains, interrupted only by deep, narrow, and beautiful glens; of which the sides, almost too steep to be climbed, are feathered with oak coppice; while the bottom is occupied by streams which dash along rocky beds, sometimes in a continuous waterfall. The wild stag has not yet disappeared, and is often followed in a straight course of 20 miles across these western highlands. On returning to the Exmoor country in 1841, I was surprised to find that moors which had formerly appeared to be fitted only for the pursuit of the blackcock and the deer, consist in great part of sound land—not in my own opinion merely, but in that of the farmers, one of whom

said to me, "Here was land enough idle to employ the surplus population of England." The expression, I now believe, would be literally true if applied to the country at large. On the Exmoor wastes you find the heath growing knee-high—a proof that the land has strength; you frequently find tall ferns mixing their bright green or yellow fans with these purple bushes: yet fern is an unfailing sign that the land has depth as well as goodness, and wherever ferns grow, unless indeed the elevation be too great, wheat might be reaped. But in that neighbourhood there is a wonderful indifference in the owners to the use of their land; which struck me the more, because I had not yet observed it elsewhere. These moors are divided into large sheep-walks for neighbouring farms. The sheep, a dwindled breed, are kept for their wool, and are sometimes left to die on the hills, of old age, in the snow. The rent may be 1s., or perhaps 2s., an acre. Sometimes you find a large piece of the best land enclosed with a high fence, and you hope that the owner is about to begin tilling his freehold. On the contrary, the object of this improvement is to keep out the only sign of farming, the sheep, and to preserve the best of the land (because where the land is best the covert is highest) an undisturbed realm for the blackcock. Every blackcock killed by an owner of these moors has cost more, I was convinced, than a full-fed ox: though, indeed, it is nothing new that sporting should impede farming. The New Forest was made for the deer, and Henry I. afforested 70,000 acres of fens, "doing," as Dugdale says, "for the pleasure of hunting, much harm to the commonwealth." In later times, when it was proposed to lay the Fens dry, the fenmen opposed the scheme obstinately, and their main argument (as I found in a curious old pamphlet) was the destruction that would fall on the wild-ducks and other water-fowl. In the last generation we have seen how rabbits resisted the long-woolled sheep; and now blackcocks and grouse, I believe, are the main impediment to the extension of cultivation. On the Somersetshire moors the sheep are indeed generally admitted, but the rent of the land, as I have said, is 1s. or 2s. an acre—quite sufficient for such feed as the animals find. Yet there is land so let, for which I know that in Berkshire 30l. an acre would be a fair price; and if the landlords in Somersetshire sold some of their moors at a rate calculated on the present rental, that land I found, on riding over it, would be as cheap as any that can be obtained in the backwoods of Canada—not only as cheap, but more easily cultivated, near a much better market, and, above all, at home. Nor is this goodness of moorland confined to Somersetshire, as I have since ascertained. I may mention Tansley Moor, near Matlock, in Derbyshire, covered with heath, but also with fern. It seemed to me to require

nothing but the plough to become an excellent farm. A great deal of worse moor, indeed, has been already enclosed: and a farmer informed me that, if he were allowed a field even of that inferior quality for one year rent-free, he would be content thenceforward to pay for it 10s. an acre—an important statement, as proving how trifling, in his judgment, is the outlay required for bringing this waste into a state of production; and this is a point which makes the neglect of our moors the more extraordinary.

It is about Matlock that the great central chain of moors begins which, running northward between Yorkshire and Lancashire, spreads into Scotland. I have not examined this chain, as I had hoped to do: but near Bakewell, 10 miles beyond Matlock, Mr. Greaves, an excellent farmer, showed me land which he had himself enclosed from the moor, bearing crops which would be good upon any old arable land, and that without having been drained; for though even draining is no longer formidable, now that the materials are reduced from 90s. to 21s. per 1000 feet, Mr. Greaves's farm, like much other moor-land, was by nature perfectly sound. Between Bakewell and Chesterfield you cross the main ridge, now lying as shooting-moor, and see fern in the heather. At the summit, however, is a newly enclosed farm, of the Duke of Portland's, in a fair state of cultivation. Northwards, again, towards Sheffield, the shooting-moors occupy, I am told, good land; and at their summit, also, a single but very productive farm is to be found. In Northumberland, north of Alnwick, there is a long ridge of good moor: but beyond the borders, from a high hill near Abbotsford, between Selkirk and Hawick, you look down upon a large part of South Scotland, and east, west, north, and south, you see nothing but one ridge of moor-land rising behind another—all, I believe, reclaimable land: though these Scotch moors seem to require draining, and so far expense. But the most extraordinary piece of waste ground is one I have just visited in England, Cannock Chase, a low ridge of 13,000 acres, in Staffordshire. The greater part has fern in the heath. A piece which was ploughed up for examination seemed a reddish, warm loam; but a gentleman who had surveyed the whole moor, told me that this was by no means the best part of it, that little of it required draining—that he should put the whole, if ploughed, at from 10s. to 15s. an acre—and that there were 500 acres, every one of which was well worth 2l. to rent if it were broken up. Yet the only stock on this moor are a few starving sheep; though I saw grouse in abundance. Now this fertile wilderness looks down on one side upon the Potteries, and on the other side you may see the fires of the Dudley iron district, where vacant hands cannot have been wanting of late for its cultivation. It must be almost within view, too, of Lincoln Heath, where no ferns can have

grown. But though many of these moors might easily be brought into the state of that Heath, if they were treated with Lincolnshire energy, the treatment would not be precisely the same, because most of them are towards the west, and though no precise line can be drawn, there is a natural distinction in farming between the western and the eastern sides of our island. The eastern side may be called the corn side of England, because the drying east wind produces on that side grain of finer quality: the western is the grass side, because the moist and soft south-western brings up grass spontaneously, as in Ireland, upon naked land; whence has arisen the old practice of keeping land for four or five years in corn, and alternately for as many in grass. Another distinction between the two coasts consists in the use of lime, an unusual manure towards the south-east, because on that side the soils either contain lime or have chalk generally under or near them; while the western soils, being usually devoid of it, the cartage of lime for periodical dressings becomes one of the farmer's principal troubles. In the Exmoor country, a hill farmer may set out in the morning, riding one horse, and driving six others with paniers (for there are no passable roads); after travelling 18 miles to the seaside and back, he may be seen in the evening bringing home 9 bushels of lime, which will dress one quarter of an acre. That wild highland tract is also under the disadvantage of great elevation, so that harvest is tardy; and it may be objected, I know, that, however good the land, the climate is a bar to its culture. On Brendon Hill, however, is a farm which proves that elevation may be overcome. It stands 1000 feet above the sea; and has been reclaimed from the surrounding moor by Mr. Roales, who settled there, among the clouds, in 1816, in a house built for him by the late Lord Carnarvon. In November, 1841, I went over every field of it, and found excellent crops of oats, about 60 bushels per acre; though the average produce of oats grown on the old land in the parish is said to be not more than 30. Wheat he certainly could not grow at that height: but, on 20 acres of seeds, he had folded 100 large sheep, the grass growing in summer as fast as it was fed off; and had sold them, fat, at 12s. advance per head; or 3l. profit per acre. Behind his house was a field, in which I have myself followed black game; it had been broken up only two years, yet had been brought into excellent grass, though the heath had been short, and without fern. Mr. Roales first pared and burnt, and next limed it with 60 bushels an acre. He did not plough it at all, because he had one inch of clear soil only, all below being rubble; but he stirred it a foot deep with a scarifier. The ashes of the heath secured him turnips, which he fed off on the land. Even then he did not take a corn crop, but laid down his new enclosure to grass, which was so

good that many farmers had ridden over to view it. After twenty-four years of conflict with this high moor and its climate, Mr. Roales was ready to convert another hundred acres of heath, provided a boundary fence were put up for him : for fencing, not draining, is the chief expense in taming these moors. The fence is raised against a special enemy, the Atlantic gales, which sweep this whole western coast. It is a broad bank of earth, 5 feet high, supported on each side by walling, and planted along its summit with beech, forming a hedge 20 feet high. This is called succour ; without it stock does not thrive ; and even corn crops, on these heights, are better by one-fourth for being well sheltered. The growth of the trees on these earth-walls must arise from the moist air of the country : in South Devon vigorous oak timber may be seen upon them. Such is Mr. Roales's experience of moor-land at the height of 1000 feet. On the opposite side of the moor, 20 miles from this place, Sir Thomas Acland's farm of Clotsham has been gained from the waste on a ledge of Dunkerry, which rises boldly from the Bristol Channel to the height of 1670 feet. The elevation of the farm itself is 1100 feet. Yet, on this crest of Clotsham, hanging almost precipitously over the low valley of Holnicote and the sea, I saw not only excellent oats and turnips, but good water-meadows, on the very brow. Strange as the situation would elsewhere be thought for water-meadow, in West Somerset it is not uncommon ; and as the plan of these meadows is peculiar, and may be widely applicable to the improvement of heaths, I will endeavour to describe their formation. Along the Lambourn, in Berkshire, and more extensively by the streams of Hampshire and Wilts, water-meadows have long since been formed. The water, it is well known, is thrown over them in winter, and produces a fine growth of grass in spring, while the other pastures are brown. But as it must trickle over, not stagnate upon the surface, these fields must generally be thrown up with the spade into high ridges, that the water may flow along their crowns and escape in their furrows. Hence arises an outlay of from 10*l.* to 20*l.* on an acre in their formation ; and hence I doubt whether, now that sheep can be fed in spring on late-kept roots, such an outlay is generally expedient ; though, as water-meadow is worth a rent of 4*l.* or 5*l.* an acre, if the money can be spared from other objects, the cost will be repaid. These water-meadows may be seen sometimes by the rivers in West Somerset ; but on the slopes of the narrow glens, you see what is much more important, the Catch-meadow. In forming a catch-meadow the ground is not re-shaped, but shallow gutters are carried at a level round the slopes of the shelving field, tier above tier ; and no separate channel is required for carrying the water off, because, after flowing over from one carrier it is *caught* in the one below ; from

which circumstance the name is derived. As you follow the small but rapid rivers, you frequently see, along the sides of the valley which rise steeply above, clear spaces opened in the high bank of oak-coppice covered with grass of emerald-green by the hill torrents, which have thus been guided and distributed along the slope. The ease with which these catch-meadows are formed is remarkable. A hill-farmer at Winsford showed me a field so steep that one could not climb it without the aid of the hands. It had been rough ground, worth 5s. an acre: he had limed it, and allowed his labourers to break it up and take potatoes for two years; after which time they returned it to him, with the water-gutters traced along the slope: so that, instead of waste at 5s., he obtained, almost for nothing, a field bearing perpetual grass, worth certainly 40s. an acre. Great as the change is, and strange as it appears, the practice is a part of every-day farming in this hilly district, and these catch-meadows meet you at every turn; indeed the word meadow here means only watered grass land. Mr. Roales has formed them from the moor on Brendon Hill, and Sir Thomas Acland near Dunkerry Beacon. Mr. Blake, of Upton, has brought less than 400 acres, which had not let for 1*l.* an acre, to produce him 1200*l.* a-year, chiefly by catch-meadows, which he formed out of moor-land, and lets each year as summering ground to the low-land farmers. There are some beautiful catch-meadows at Cutcombe Pass, on very high ground, south of Dunster Castle. In Devonshire, too, Mr. Hoare, at Luscombe, near Dawlish, has made them from very poor land, on which he turns the water, first in the winter to feed, then to mow, and then three times afterwards in the summer to feed off the herbage in the course of each year. I saw some also at Mr. Turner's, of Barton, near Exeter; and the late Mr. Bulteel made them, I believe, largely near Plymouth. On one farm at King's Brompton, near Exmoor, the tenant had drained a piece of moor-land, collected the runnings into a reservoir, which the present Lord Carnarvon had built for him, and used the water, which had been poison above, as food for the field below. For it is remarkable that water which has flowed over a bog is injurious, but, brought by under-drains from the same bog, is nutritious. I do not mean that these catch-meadows were all made without expense; but, where the land is previously dry, 2*l.* or 3*l.* per acre would be a fair estimate of the cost: and in order to show what improvement may be effected by catch-meadows, I will only mention one case, pointed out to me by a farmer at Winsford, as perfectly easy to be carried out upon a neighbouring farm. That hill-farm consists of 232 acres, and is let for only 75*l.*; but, as the farmer observed, 100 acres are a steep slope, covered with rough grass and short furze, worth about 5s. an acre. Now there are two copious springs gushing forth near the brow which might be

turned along the wild land, and thus, for 2*l.* or 3*l.* an acre, the worthless slope would be converted into catch-meadow, which elsewhere would be worth 60*s.*, and even in that secluded spot, 40*s.* an acre: so that the value of this farm might be raised, for 300*l.*, from 75*l.* to 250*l.* yearly. This is a farmer's plan, and a moderate estimate. There are several practices of English farmers changing the nature of land at a moderate cost—transformations of soil, which I have brought before the Society; the application of chalk; the use of marl on sand, which was the foundation of the improvements of Holkham; the use of clay upon peat in the fens, which makes hollow land close and good; there is the old English practice of thorough draining, on which all are agreed; but no discovery has surprised me so much as the marvellous effect of hill-side irrigation—for while under-draining, after great labour, may add 10*s.* to the value of an acre, in West Somerset a mere rill is made to produce on the barren flank of a moor more abundant herbage than the old grazing land of Northamptonshire yields. The method seemed to me capable of wide application, as it requires but trifling outlay, a rapid stream untainted with peat, or even a bog capable of drainage, and moderately sloping ground, however poor. There is no doubt that it might be widely extended in its native district round Exmoor, and I should think also in Wales. There are many tracts in the north of England, and I have seen many valleys in Scotland, which, if they were in Somersetshire, I could not doubt would be covered with catch-meadows; but the climate of the north may counteract irrigation. I have not seen it farther north than at Teddesley in Staffordshire, where 80 acres of catch-meadow have been formed for 224*l.*, or about 50*s.* an acre, and 40*s.* added thereby to the yearly value, a return on the outlay of 80 per cent. This place embodies all the principles of moorland improvement. When Lord Hatherton came to reside there in 1820, his house was surrounded by heaths and by alder-bogs. Of these he has under-drained 500 acres, at the moderate expense of about 3*l.* an acre, and upon them are fine swedes and clean wheat-stubbles. All the water thus tapped from these bogs is conducted to the farm-yard, where it turns a wheel which threshes the corn and does the other work of the barn. Thence this subterraneous water issues forth in a full stream, and finally, divided into slender rivulets, spreads verdure over the catch-meadows, carrying with it the liquid manure from more than a hundred beasts kept in the yard summer and winter. The beauty of this arrangement, which resembles the complicated functions of an animal body, is as striking as the practical benefit of changing a morass into a sound corn and stock farm, for the farm of 1250 acres carries 1500 sheep, besides more than 200 head of cattle. I know of no farm which offers so

perfect a model for the improvement of moor-land lying towards the west side of England. But the importance of enclosing our wastes has led me too far. An objection, however, is made which carries us back for a moment to Lincolnshire. Enclosures, it is said, injure the poor. Now Lincolnshire is one new enclosure from Cambridgeshire up to the Humber: yet I know no county in which the labourer is better provided for. His wages vary from 10*s.* to 12*s.* and 15*s.* a-week: he obtains a great deal of taskwork,* for more labour is thus paid here than elsewhere—filling dung-carts, for instance, at 2*d.* per load, and the harvest-waggon at 1*s.* per acre, which diffuses activity through the whole operation. Good hands are at this moment earning at task-work from 15*s.* to 18*s.* weekly. His cottage—unlike the hovels of Northumberland and of Scotland, where one room on the ground holds the family, however numerous, by day and by night—is neat and cheerful. Many labourers have allotments, and some even cows. So far from injury accruing to the labourer by enclosures, it is clear in theory, as it is proved by the practical contrast of Lincolnshire with Dorsetshire, or of Derbyshire with South Wales, that where the demand for labour is stationary, wages must be low, but that they will be raised wherever the plough breaks up new fields of employment. The Lincolnshire labourer living among new enclosures is well paid, clothed, lodged, and also, I should mention, well fed, sometimes with fresh meat. The consequence is that being better fed they are able to work harder than other labourers; and thus the farmers are repaid for their expenditure upon their men as well as upon their land. Indeed what Arthur Young said, five and forty years since, of the Lincolnshire farmers may be said now:—"I have not seen a set more liberal in any part of the kingdom: industrious, active, enlightened, free from all foolish and expensive show or pretence to emulate the gentry, they live comfortably and hospitably, as good farmers ought to live: and, in my opinion, are remarkably void of those rooted prejudices which sometimes are reasonably objected to this

* The following remark is from a Lincolnshire agriculturist:—Whether "task" work be more in practice in Lincolnshire than elsewhere I, from my retired habits, know not, but it is a practice highly beneficial both to the farmer and labourer; the one gets infinitely more work done, and the other more wages and better habits; for instance, in filling the carts with manure by the day the labourer seldom fills more than 8 or 9 loads, whereas for days together, this year, I had 160 loads of manure, each load 1½ cubic yards, filled by 10 labourers, at 1½*d.* per load, and spread upon the fallows with 9 carts, 9 horses, and 9 of my own men, and 'generally finished by 2, never later than 3 p.m., sharp work of course, but the labourers push everything else on, no creeping, and they thus earn 2*s.* 4*d.* a-day, and have ample time to do a little work in their own gardens in the evening.

race of men. I met with many who had mounted their nags, and quitted their homes purposely to examine other parts of the kingdom, and done it with enlarged views, and to the benefit of their own cultivation." They have visited other districts, and they have since so managed their own farms that these deserve to be viewed in return. Practical farmers may perceive defects which escaped my observation; but if they see Lincoln Heath, or the Wolds, either in harvest or later in winter, when the sheep are in the fold and the cattle in the yard, I do not think that they will be disappointed. They will see the result of great expenditure on the part of the landlord as of corresponding energy on that of the tenant; and if other owners of desolate places should be encouraged by the example to fit them for man's use in like manner, thereby enriching their families, multiplying farmers, strengthening and, one may say, enlarging their country, above all raising the weekly dole of the labourer, by the only means of raising it, namely, by ploughing up fresh land on which the labourer's arm will be wanted, I earnestly hope that on whatever moors their buildings may be reared or their fields be enclosed, they may be no worse seconded in their praiseworthy efforts to pioneer for posterity than Lord Yarborough and Mr. Chaplin at Brocklesby and at Temple Bruer.

XXII.—*Report on Mr. Newberry's Dibbling-Machine; from*
J. H. LANGSTON, M.P., *and the other Referees.*

To the Secretary.

SIR,—I am desirous to lay before the Society a statement of particulars relating to a dibbling-machine invented by myself, which statement I should be most happy to corroborate by facts if the Society would depute a person to view the crops planted by myself with the dibbler, as well as by others in this neighbourhood. The first crop planted by it was wheat, four years since, $1\frac{1}{2}$ bushels per acre, wet poor land in Essex, about 3 acres of ground. It was said to be a better crop than the land usually produced; but as there was no other wheat planted but what the dibbler did, we could not form a comparative advantage. The next was in Essex the following year: rather heavy land, about $1\frac{1}{2}$ bushel per acre: done in wet, the plants looked thin all the winter, but at spring and during the summer showed a superiority over the drilled. It was at harvest 4 to 6 inches higher than the other, the ear much longer, no under-corn, and stood erect, owing to the

strength of the straw. The next year I had it on my own farm here, after clover, 11 acres of ground, went across the furrow without harrowing, about $1\frac{1}{2}$ bushel of seed per acre. Drilled one strip across the ground—dibbled the next—sowed the next—and so on alternately. My neighbours soon saw a marked difference in the plants; and during the summer the general remark was, that one piece looked as if *mucked*, the other not. At harvest the result was a decided superiority.

Last autumn I had greatly improved the machine, and had numerous applications to plant, which I did for any one, at $1\frac{1}{2}$ bushel per acre, in small strips about 2 or 3 acres, in a ground where the drill was used on all kinds of soils; and the result is a superiority over the drill, which I am sure no one would credit unless they saw it. In the spring I planted barley, oats, and a few beans: the 5 pecks of seed beat everything I have seen of oats. I have had many gentlemen to see the crops, and all say they would not have believed it unless they had seen it. As we have gentlemen, members of your Society, living in the neighbourhood, I should be most happy to show the crops to them, or any person whom the Society may appoint, or to give any further information on the subject,

And remain, Sir,

Yours, very respectfully,

W. NEWBERRY.

Hook Norton, May 24th, 1843.

Report from Mr. Langston and Others upon the foregoing Letter.

SIR,—I shall feel obliged by your laying before the Council the Report which I have drawn up at their request. I asked four of the most intelligent farmers to accompany me when I examined the crops planted by Mr. Newberry's machine; and, with their approbation, I have added their signatures to my own.

I remain,

Yours truly,

J. H. LANGSTON.

Sarsden, November 14th.

WE, the undersigned, have at your request examined the effect of Mr. Newberry's dibbling-machine, and have no hesitation in reporting the superiority of the wheat-crops where the seed had been planted by that instrument over those which have been sown broadcast, or drilled. We had many opportunities of comparing, side by side, the produce of these several modes of treat-

ment; and in every instance found the dibbled wheat to be much longer and stronger in the straw, finer in the head, and much more free from diminutive ears; it was also much less lodged; we attribute this to the pressure of the rim, or iron roller of the dibbler, giving the seed a firmer bed, sufficient grains being placed in each hole to guard against contingencies and supply the crop; but as vegetation advances, each plant having space to expand, and thus to derive more nourishment from the soil and atmosphere than those which are placed more thickly in the drills.

We found that the machine deposits the seed very regularly, at the distance of 6 inches; both the quantity in each hole, and the distance between the rows, can be easily regulated by the person using the implement—1 bushel and a peck per acre Mr. Newberry recommends, and we believe it to be amply sufficient. In corroboration of our opinion we have received several letters from farmers who have tried this instrument both on heavy and light soils, stating that they have saved 1 bushel per acre in the seed, with a prospect of a much larger advantage from the increased produce. We think also the dibbler is likely to become of general use in the planting of beans, as it will enable the farmer to clean them more perfectly.

In conclusion, we beg to state that Mr. Newberry is, in our opinion, entitled to the thanks of agriculturists for the exertions which he has made to bring this implement to perfection; and we hope that the patronage which he will receive may repay his labour and expense.

JAMES HAUGHTON LANGSTON.

THOMAS BAKER, Little Rollright.

THOMAS CARPENTER, Hall Farm, Chipping Norton.

JAMES HUCKVALE, Over Norton.

HENRY FOWLER, Kingham.

XXIII.—*On the Drainage of Land.* By THOMAS ARKELL.

PRIZE ESSAY.

INFORMATION required to be given under the following heads:—

1. *Depth and frequency of drains.*
2. *Materials: tiles, stone, or peat, &c.*
3. *Filling in, whether with tenacious or porous earth.*
4. *Expense of various methods.*
5. *Direction of drains having a considerable slope.*
6. *Fall required.*
7. *Disposition of drains.*

8. *Benefit from increased crops, admitting a new mode of culture; and stocking, advancing the time of harvest, reducing the amount of horse labour on heavy soils, improved climate, &c. &c.*

9. *Durability of drains.*

10. *Past and present practice of draining in England.*

11. *Districts of England which require the most extensive effort in underdraining.*

In looking over these different heads I come to the conclusion that more information is required *how*, than *whether*, drainage should be done.

What I should consider your object must be in offering the prize is to get the best *practical* essay on draining sanctioned by your Society, and circulated in the most extensive way possible, for the benefit of the country at large, but more directly among all persons who are, or ought to be engaged in draining, so as to check the great waste of money expended in inefficient draining, and also to check unnecessary expense, which causes a great deal to be left undone from fear of the outlay: such an essay is necessary, especially if every part of the country require it as much as this, for according to the small quantity I have seen done in this neighbourhood, a good portion has been done in an inefficient manner, that is, if the several pieces were to be drained effectually, those that are made would save a very little expense according to their cost; some are not even worthy the name of drain, not that I blame any man for doing a little, provided it is done in a manner not to want doing again, and can be extended as opportunity offers; for many can spare a little time and money every year, who cannot proceed on an extensive scale, because their landlord will not or cannot help.

Before commencing, I will just state that my experience extends over about twelve years, in which time I have made between 3000 and 4000 chains of drains on grass and arable land, principally at my own expense, though I am but a tenant-farmer, so well am I satisfied of its advantages; and I am happy to say it has had the desired effect (with one or two exceptions, which will be stated in the proper place), viz., keeping the land dry without the expense of making open furrows and trenches, admitting an improved mode of culture, by keeping stock in a thriving and sound state, (which was not the case with my predecessor, the principal part of whose flock was sometimes rotted in wet seasons,) increase of crops, with decrease of horse labour. Besides what I have done myself, I have generally taken the trouble, if I happened to see any draining in my travels, to examine the manner in which it was done, the nature of the soil, &c.; amongst the rest Earl Ducie's example-farm, and all must

admire the masterly way in which that farm is drained, and the beneficial manner in which it answers; so much so, that persons going to see it now, find it totally unlike the nasty wet land it was described to be when the late tenant had it: on the other hand, I have seen where persons have gone to a great expense, and the land very little drier than before. Two instances I observed a few days back; one was a rubble drain, about 14 inches deep up the piece, and then turned across at almost or quite a dead level; the other was an attempt to drain a flattish piece of clay-land with tiles laid barely a foot deep, and some bushes and straw placed at the top of them, I suppose to keep the soil hollow and to admit the water. But it is easy to see the consequence of laying tiles only 12 inches deep just in the place where the cattle must knead the soil over them every time that the land is ploughed; such draining and much more equally absurd, perhaps, is one reason that it has not advanced more in different districts; for that these shallow cuts will not drain the land is not to be wondered at, but instead of laying it to the mode of drainage, it is said that the farm is such *extraordinary* land, it will not drain, "the water will even stand within a foot of the top of the drain."

Before going over the different heads, it will be necessary to know what land requires draining; though this is easily known, still it is not sufficiently known, or at least acted upon by a great number of owners and occupiers of land, and I would wish to make this essay capable of being understood by every one, even the labourer who has a wet garden. But first, a word on the term *surface-water*, which, I think, has misled many. Land is said to be wet from surface-water when the wetness is caused by the rain that falls directly on it, and it is free from springs. This is true, but if the surface be wet, the subsoil is equally so, and becomes overcharged with water *first*, consequently requires draining on the same principles as springy land. When I have seen drains being put in about 16 or 18 inches deep, I have said, "Why don't you put them deeper?" and the answer has been, "We only want to catch the surface-water." But if the subsoil be dried, the top will certainly be so: now the water enters the drains at bottom, whether the land is wet from surface-water or from springs; it does not run along the surface to the top of the drain and enter there, as many people appear to suppose.

The means I take to find out whether land which I am doubtful about requires to be drained, is, when the springs are at their height, which is often in February, to go over the land about twenty-four hours after the rain has ceased, and make marks where drains are necessary, which will be where you find the land wet as you walk up the furrows; and if you are not quite satisfied, dig a hole about 18 inches deep; if you find water, be

satisfied it wants draining. Such trouble will be unnecessary on clay-soils and subsoils in a *flat* country; these you may be certain require it. If such soils have a considerable slope, it may be more questionable, but in general they will, although some argue that where land has a considerable fall, and the furrows and trenches are kept well open, draining is useless; but you may be sure that where water furrows and trenches are necessary, draining is required; but upon clay-soils with a porous subsoil it is quite necessary to take the above trouble if you want to do no more than is really requisite.

A good portion of my farm is a strong clay-soil on the oolite or coral-rag formation.* This land is very wet, and even on some of the lightest, which is only 6 or 8 inches deep in soil, when the springs are very high, you cannot walk across it without sinking over your shoes; other parts again, though deeper, are dry. It is almost, if not quite (I should say quite), certain that arable land requires draining, if the water runs off the top when the land is left in a healthy state, except after particularly heavy rains for a short time. What I mean by a healthy state is, that it has been worked off in a dryish state at the fall of the year, not trod and smeared about in the wet; for you certainly may work dry land that is of a clayey nature so that it will hold water in the horse-treadings like so many cups, even after it has been drained; that, however, is not the fault of the drains, but of the farmer, though some think it a proof that such land will not drain; but a horse stepping on a wet clay soil is somewhat like a potter tempering his clay for pots; each will hold water. I was once told that it was of no use to put drains in a field that I was looking over, as the water would run over them without entering; but I found afterwards that in this case the drains had been cut across the fall. Such remarks, I confess, used to have a little more weight than they have lately, but they led me to a more minute inquiry in order to know why such things were, and now I do not hesitate

* I sent a portion from the lightest part of the field to be analysed; the following is the return and remarks:—

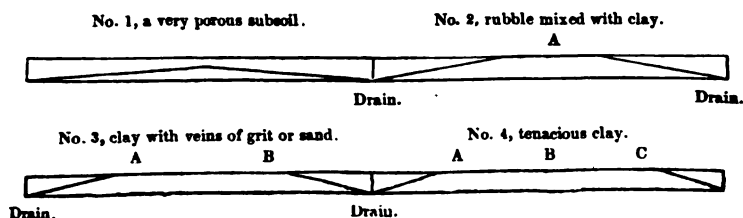
The supersoil has the appearance of a clay loam, with large particles of limestone, being the débris of coralline oolite.		120 grains of the subsoil:—	
120 grains consist of		Moisture, salts, and matters dissipated by fire, 20 grains	
	grs.		grs.
Water, soluble salts, and vegetable matter	19	Sand, with small portion of iron oxide	17
Sand, with small portion of iron	45	Clay	5
Clay, coloured with iron	46	Lime, carbonate and phosphate from coral	12
Lime	7	White sulphate of iron, some arsenic	80
Loss	3	Loss	6
	120		120

in saying that there is no land, let it be ever so tenacious, but will drain, if the drains be done properly.

With regard to the draining of grass-land, there is a difference of opinion, especially on good land that is wet but feeds sweet; I never had any such, or I should certainly try drainage, though it is said that less grass is produced; and if such be the case where the quality is previously good, there must of course be an injury; but it is my opinion that you cannot injure any land by draining; you may put a drain on very dry land, but that would not injure it, as no water would run off through the drain. Strong land that is wet in the winter becomes dry in the summer, cracks, and requires more rain to make the grass grow than land of the same nature that is drier; but, after strong land has been drained a few years, it becomes milder, never getting so hard in summer, nor so wet and soft in winter. I should say that when water stands on the surface, or whenever to prevent it from standing it is made to run off the surface by furrows (except where there is sufficient for flooding or drowning, which is not an excess because it is beneficial), but where it is stagnant on the surface, and left to evaporate by the heat, then there is an excess of moisture. On wet, sour-feeding, middling grass-land I think there is no doubt that draining would be beneficial, but it would be more likely to lessen the quantity of grass on this description of soil, which generally grows a coarse, sour sort of herbage, still the quality will be improved, and the old saying will apply here, "a lark is worth a kite." Some, perhaps, will argue differently, saying that the wettest part is at present the best, viz., the furrows: so they are, if they are not trenched out, because the water running off the ridges by the furrows causes a natural water-meadow just down the furrow; but it is easy to see which is predominant, the injury to the ridge, or the benefit to the furrow. You cannot indeed expect by draining middling or bad grass-land to make it good directly, but the land will improve afterwards: the manure, whether carted on, or produced by feeding-off the grass, will be more beneficial by being all washed into, not off the land, as is now the case. What can be plainer than that after the land has been fed through the summer a good portion of the manure is *on* the surface at the fall of the year; the first rains naturally wash a portion in, until the land gets saturated; after that every successive rain carries a portion off, besides encouraging the growth of a coarse herbage, to the detriment of the finer grasses. I drained a piece of very poor clay-land last winter, when a sort of grass, of which I do not know the botanical name, but known here as pink or carnation grass, a dwarf sedge-like grass, was very strong; now this winter it is not nearly so strong, and the sward appears thinner, making room for the better sorts of grass when a


little manure is applied. There is another very essential benefit derived from draining grass-land, which is this, that in very grassy seasons, which are generally wet, the land will not become poached so soon, therefore the cattle can remain out to consume it later in the year, without so much waste of food or injury to the land, which will also be made sound for sheep, though these are not the stock for grass-land generally; still there are times when they can be kept on it to advantage, if it be dry and sound. Having *tried* to make it appear plain what land requires draining, I will now endeavour to state how it should be done by answering the questions proposed by the Society.

The Depth and Frequency of Drains.—The one must be partly ruled by the other; if you cut the drains deep, they are not required so frequent; if they are put near together, they need not be so deep. This rule will hold good to a certain extent on all descriptions of soil, but from the great variety which exists in the retentiveness and porousness of soils, you cannot reduce the depth and distance to one fixed rule. Land that lies in ridges (or lands as the term is here) is generally drained in the furrows, and though the ridges are of very various widths, if they have a considerable slope up their sides, say from 1 in 10 to 1 in 20, the drains along the furrows will be sufficient to keep the ground dry, if put in at a depth of 24 or 30 inches, the latter being preferable; but on some retentive clay-soils, where the slope is 1 in 40 or less, and the lands more than 12 or 14 yards wide, it will require them deeper, or else more frequent. Land lying in ridges is generally drained at the least expense; from its lying in a round form, part of the land is in a measure drained, and by putting the drains in the furrows, you keep a piece of land dry, perhaps 16 yards wide, whereas if the same description of soil were level, it might want draining at 6 or 8 yards' distance. I have heard of land lying in ridges being drained at equal distances, paying no regard to the ridge or furrow; but this plan must be wrong, even if you go deep enough to drain it, from its costing a great deal more in cutting through the ridges. Now the chief point in laying out drains is to know how far your land will draw from the drain. The following is a rough sketch of the power of drawing in four different subsoils, with drains a chain apart, 30 inches deep on level land:—



No. 1 will drain the whole width, and keep the water 18 inches from the surface, the fall of the water in passing through the soil being 1 in 33. I drained a piece this winter at about this power of drawing, which I proved by digging a hole midway between the drains. No. 2 would require one more drain at A, or 11 yards apart. No. 3 will want two more at A and B, or $7\frac{1}{2}$ yards apart; and No. 4 three more, or at A, B, and C, or $5\frac{1}{2}$ yards apart. This will drain any soil; the internal fall required by the latter, if the water is kept only 1 foot below the surface, will be about 1 in 6, which is very great, perhaps greater than any land has. It may be asked how and when is the proper time to judge of the above; perhaps the easiest way to find it out will be, after you have made two drains parallel with each other, at the distance which you *think* the land requires, to dig a hole midway between them of the same depth with the drains, and so ascertain the height at which the water stands above the drains in the rainy season, proper time being allowed for the water to go off, according to the tenacity of the soil; say two or three days after rain in February, when the land is generally as wet as in any month. It will also show itself before land is drained, if the land has been ploughed in ridges. In fields where the ridges are not very high, I have seen the water stand on the top of them; and where they are high, they are wet some way up from the furrow, according to their steepness or the tenacity of the soil.

As you cannot fix a rule for both depth and frequency to suit all soils, I should say that, with few exceptions, the depth should be 30 inches, and from 22 to $5\frac{1}{2}$ yards' distance; a few instances wider, but few requiring them so near as $5\frac{1}{2}$ yards. I drained a piece of poor wet clay-land, which I was told would not draw a yard; but I found the drains act at 7 or 8 yards' interval, or 4 yards on each side of the drain. Though deeper draining would require fewer drains, it is not always advisable to cut deeper, as sometimes it is very difficult to get a proper outlet for the water without extra depth of ditches, which cannot always be obtained.

The Materials I have used are tiles, stone, and clay. For land having little fall, hollow drains are best, because there is a better passage for the water; therefore on such land tiles are best, and on clay-soils there should always be some flats put under them; some tiles are made with feet, thus, ; but that I should not trust to on clay-land, and on rubble or gravel it is unnecessary. Besides, flats or chips of slate, about the size of one's hand, for the ends of both tiles to rest on, leave the tile hollow from the ground, which will allow the water to enter better than if it rests on the clay, in which, even if the tile does not sink deep, it will in time become firmly imbedded, and the entrance of the water be thereby retarded; for this reason, I should say, such pieces

are better than flats of the same length with the tiles, excepting on running sand or very soft ground. Stone drains are various; the most common here are wall and dribble, or rubble, the former as main, the latter as tributary. Perhaps there is none so good as a wall-drain, but the expense is too great for extensive use. The dribble is made with stones, broken about the size of which they are used for roads, the drain about 8 inches wide, filled a foot high with the stones, and a little straw put on them to keep the dirt out until it is settled down; such drains answer a good purpose where there is a fair fall, say from 1 in 20 to 1 in 60, and put in properly; that is, the stones clean, and at the depth of full 30 inches, as the deeper they are put in the less likely they will be to choke from the entrance of the soil. There is another description of stone drain I have seen, which is very good, but it must be naturally confined to certain districts on account of the description of stone required, which is a thin, slaty rock; the stones 1 or 2 inches thick; one stone is placed upright against the

side of the drain, and another leant against it, thus,



and a

few small stones filled in over them, thereby forming a hollow drain at little expense, a waggon-load doing a chain in length.

Clay-draining is a very good kind of draining, if done on the proper description of soils, and very much to be recommended on account of its cheapness and durability, although I am aware I may meet with opposition to this opinion. I have known it partially in use about twenty years, but within the last eight or ten it has made considerable progress in the districts I am acquainted with. It was first used on pasture, which perhaps it is most suitable for; but it has answered the purpose on arable land; it also shows the way in which drains act more clearly than most others, namely, that the water enters them at bottom, not at top, as is erroneously supposed by some. I think it was first tried by a celebrated mole-drainer, whose name I forget, who no doubt found the difficulty of getting mole-drains to stand any length of time, on account of portions failing and spoiling the remainder.

Wood has been in use for draining a great number of years, and is still in use to a certain extent; but, except on bogs, or soft ground, it cannot be used to so good purpose as stone or tile; for after it has been in some few years, it is liable to choke up when the wood is rotten, although some may stand a number of years, as I have heard persons say who have dug across wood-drains

that have been made upwards of fifty years, still good, though with no remains of wood left; and what is that more than a clay-drain?

I have known the mole-plough used, but it cannot be depended upon; some drains of this kind will stand good for a time, while others will choke up almost directly. In mole-draining there is nothing taken out; the soil being only pressed aside, no doubt soon expands again, and for this reason they soon close. Peat I have never seen used, but, if it will not rot underground, it would answer the purpose on arable land, as turf does on pasture in making turf-drains. Turf-draining is somewhat similar to clay-draining, only instead of filling the drain with the clay that is

taken out, a piece of turf cut thus,  is well rammed into a

drain cut thus,



which has the following appearance when finished,



If the turf be of the nature of clay, not of mould, or with too much vegetable matter in it (if it has, it will be likely to rot and fall in), it will last a long time; but I consider clay better than turf, as there is nothing in it to rot. I have seen turf used in a different way, by putting the grass-side of the whole turf downwards, not

ramming it at all, thus,



but I consider that a very bad

way, as the turf will soon fall in. I have put stone on instead of the turf, and it has answered very well.

Before describing clay-draining, it will be necessary to say what tools are required. They will be a common spade, a hollow one, or navigator's tool, two scoops for taking out the crumbs, one 4 and the other 2 inches wide, a tool, for taking out the bottom spit, 3½ feet long, partly iron and wood, the iron part, side view,

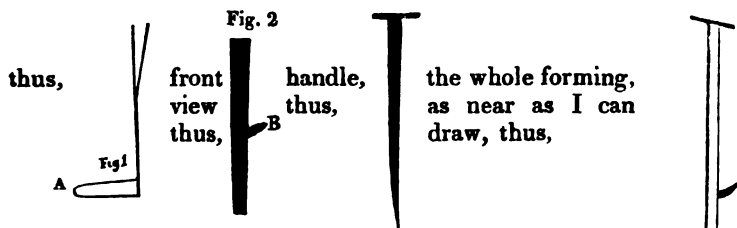


Fig. 1 is the main part, which is $1\frac{1}{2}$ inch wide and $\frac{1}{2}$ inch thick, tapering down like a common chisel at bottom; the wing A is a thin piece of steel, 6 inches long and $2\frac{1}{2}$ deep, joined on at bottom at right angles on the right-hand side; the tread B, fig. 2, must be fixed on the left-hand side, 14 inches from bottom, and stand out 3 inches long—an old

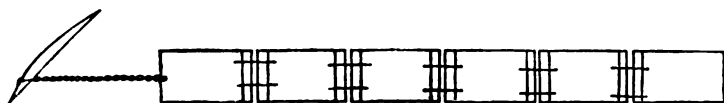
short-grained prong—a rammer thus,



made out of a

slab of board, 3 inches thick at bottom, a lever, chain, and block, the latter 6 inches deep, $2\frac{1}{2}$ inches thick at top and 2 at bottom, in six joints a foot long each, joined together with two plates of hoop-iron to each joint, let in with a saw cut across the blocks, and fastened with pins drawn through the blocks and irons, which will allow of their turning in the drains, thus,

The blocks and lever, showing the iron plates and pins, thus,



The end view thus,



with the hollows in the sides, in order

to allow the water to pass while the drain is made.

On grass-land you first mark out with the spade where the drains are to be. Take the turf off 6 inches deep and place that on one side, then take a spit out a foot deep, with the hollow spade, and place that on the other, taking care to have it rather narrower at bottom, then take the bottom bit out a foot deeper with the tool

above described, taking care to have the bottom of the drain to fit the blocks tolerably close; the way to use the tool is to cut down with the wing on the left-hand side the depth required, then withdraw the tool without moving the soil, turn the tool half-way round, and the wing will cut down the right-hand side, and the back or chisel part will cut a piece off 6 inches forward, which must be brought out with the tool; then on again, the man work-

ing backwards, thus,



or thus,



Some prefer the latter,

thinking the shoulders will catch the dust falling in if the land should crack, as it will, if it is a very dry summer the first year after it is done; but I never found any injury from this cause. After a certain portion is taken out, put the blocks in, wetting them well at the beginning; take the prong and put in first upon the blocks those pieces of clay which came out from the lowest part, treading them down; then take the rammer and ram it well down on the blocks, the firmer the better; then put on the other soil and serve it the same; put the turf on, and there is your land as whole as before. Then take hold of the lever and fix it firmly in the bottom of the drain and draw the blocks forward, leaving one joint in the piece that was done before, to support it while you make a good joint of the clay. If you have clay-mains it will require two sets of blocks, putting the end of one set against the side of the other; and in clay-draining it will be necessary to start the branch drains at right angles, as at an acute angle,



the thin part A would be likely to swill off.

“No water would ever penetrate such drains as these, on such land as mine,” exclaim some hundreds of persons, who think it necessary to fill drains with something porous very nearly to the surface. It is out of your power to keep it out, say I. What, after being rammed in as you describe? Yes; there is sufficient space below the arch of the drain, an area of 14 inches at the sides and bottom, in its natural state through which the water will percolate and enter. This kind of draining must be done while the land is in a wet state, as the block will not slip or the clay be in a fit state to ram if dry; therefore it is carried on when employment is somewhat scarce, namely, in the winter months. Although

this is a cheap kind of draining, it is one that perhaps requires rather more care taken with it than most others, so it is requisite to have trusty men to do it, as well ramming in the filling is a very particular part of it; and if the water stands on the drains after rain when it is done, it is a sign it is done well; do not therefore be alarmed, and think your land will not drain, but just go and look at the mouth of it, and if no water runs out, then you may well feel alarmed; but you will surely find to the contrary. But some wet clay-land requires a dry, hot summer before it will receive the full benefit from draining. I will state a fact in proof. I clay-drained in the winter 1840, a very wet, sour piece of pasture-land, a black moory soil on a soft clay, which appeared to drain at the time as well as I could wish; in the spring of 1841 I broke it up, and planted it with turnips, feeding them off at the fall of the year, which you will recollect was extremely wet through the fall and winter, and the land was as wet as if there had not been a drain on the piece, still all the drains ran well; but the rain falling in such continual quantities, came faster than the nature of the soil would admit it into the drains. After the turnips were off, I planted wheat on part of the piece, which was rather a thin plant from the wet; knowing the drains were all perfect, and that only a dry summer was required to make them act effectually, I did not hoe the wheat in the spring, although it would have benefited the crop, because I would not raise a mould to prevent the weather having full effect on the soil; as we all know the wetter land is in winter the more it will crack in summer; and this summer being a thoroughly dry one, it has had the expected effect, and the land is now in as dry and healthy a state as one could wish. A part of the piece was tilled for turnips again this last spring, and there being a good quantity of mould prevented the subsoil from being cracked by the summer heat, so that this winter that part has been as wet for a short time as it was last year in proportion to the quantity of rain, while the other part, as I said before, is dry and healthy. Now supposing I had drained this piece with tiles or stone, and filled in with porous soil up to the top, that would not have drained the ground much better; it certainly would have prevented the water from lying on the surface immediately adjoining the drains; but the land being ploughed level, the water would not have run into them from the surface, but must have found its way into them in the same manner as into the clay-drains. Had the ground lain in high-ridged lands, I grant that the case would be somewhat different, as this shape would force the water to one particular part. The conclusion I come to is, that tile or stone are preferable for the first year or two, especially on high-ridged land; but that after the land has had a dry summer or two clay draining is equally

effective with the other. There is one necessary precaution to take, never to make clay-drains where the water is liable to lie in them from flood or other causes, and for this reason it will be necessary to have a tolerable good fall, say not less than 1 in 60 ; also where the clay-drains are used for mains, not to get a very great quantity of water together. About 2 acres will be quite enough for one main drain ; if more, I should advise stone or tile for the main drain, and then to empty them often. My reason for saying so much on this mode of draining is this, that it is so well calculated, from its cheapness, for tenant-farmers like myself. How many such do I know who would gladly accept the offer of their landlords to find tiles for the tenant to put them in ; but how many landlords seem blind to improvements of this sort, either from ignorance, or, perhaps what is oftener the case, want of means ? Now, by this method a tenant who has any certainty of holding his farm for a term may drain it at less expense than he can haul tiles and put them in, where the land is suitable for it, and there is a great quantity of such land in this country, namely, clay-soil, with a fall of not less than 1 in 60 or 70. I have drained myself in this way about 35 acres arable and as much pasture ; and if any one has any doubt about its answering, I will refer them to Mr. Iles and Mr. Job Hill, of Poulton, near Cirencester, and to Mr. Jonah Newman, of Castle Eaton, near Highworth, Wilts ; and another person told me lately he was quite surprised at the effect it had had on flat clay-soil.

Filling Drains.—Where I have used tiles, which I have done on soils varying from a very porous subsoil to a very strong clay, I have always filled them in with earth just as it was taken out, merely treading it in to make the drain hold it ; the only soil for which I should take the trouble to procure any other material would be on running sands ; a fine running or quicksand, I have understood (as I have never had any such), is the most difficult land to drain of any, as they so soon choke up ; if flats the whole length of the tiles, and a little clay soil trod rather firmly round them, would not prevent it, I would put a little under them, to prevent the sand from rising ; if drains are made 30 inches deep and as narrow as possible, so that a man can work, there will be no necessity for that great and unnecessary expense of drawing stones or porous earth to place upon the tiles ; but if put in only from 12 to 18 inches on clay soils, then stones, brushwood, &c., are necessary to make it appear something the better for the trouble. I cannot speak too positively on the necessity of making deep drains in tenacious soils, at least 30 inches, not but deep drains are best on all, yet an 18 inch cut may drain a porous soil tolerably well, but on a clay it will not drain far ; a person told me he had some tiles taken up that were put in about 16 or 18 inches

deep with the soil as firm round them as if it had been rammed in: now into such a drain as that the water has considerably more difficulty to pass than into a clay drain, because in the latter it can pass in through the sides and bottom below the arch; but if the soil be kneaded so firmly round the tiles as to be impervious to water, it can only enter at bottom, and then naturally very slowly, as, the drains being so shallow, there is little weight of water to force it in; but if they are made as above advised, the horses will never tread it so firm as it was before it was moved; for in cutting across old drains of that depth you always find the moved soil more hollow than the remainder.

With regard to rubble draining, what little I have done I have filled in about 12 inches deep with stones, putting a little stubble or rough grass to prevent the dirt falling among the stones, then filling in the soil, treading it tolerably firm. Perhaps in filling drains with the same soil that has been taken out on tenacious clays, through which the water naturally percolates slowly, you may, after very hasty rains or rapid thaws, find the water lie on the surface for a short time. This may be the reason for which persons fill them with stones or porous earth to admit the water, but I consider the remedy worse than the disease, as such hasty rains being admitted so fast would be more likely to wash the soil in and fill them up than the mere swill of the drain itself; besides, suppose the water do lie on the land a few hours after such weather once or twice in the course of the winter, there is no damage done; it is not land being wet in wet weather that injures it, but a continued sodden state when it ought to be dry: how soon a few dry cold days will tell on such land in the spring of the year!

The expense is the great bar to this necessary improvement, especially where the owners will neither assist themselves nor let for a term, so that the tenant may reap the benefit of an outlay by himself; all the eloquence that all the speakers of this country possess will not persuade farmers under such circumstances to expend from 2*l.* to 5*l.* per acre in improving their land, nor is it likely, when they so often see persons turned out of their farms through the mere caprice of the landlord or steward, often through the dishonesty of the latter; you cannot call it any milder term, as you often see it is those that have made greatest improvements on their farms. But to the point: the expense per acre must be variable, therefore it will be best to give the cost per chain of 22 yards. I will first compare tiles with stones as they have each cost myself: I could dig stone on the farm, but I preferred making tiles, as I could not buy them under 40*s.* or 45*s.* per 1000; I have reckoned them at 30*s.* for small and 40*s.* for mains; I made them 13 inches, but they will not stand more than 11 inches

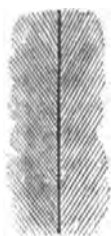
after burning; a chain will require 72, say 75, as there is always a little waste; they will be 2s. 3d. hauling one-third of a mile; 4d. making the drain, putting in and filling up from 1s. to 1s. 4d., an average of 1s. 2d., which makes a total of 3s. 9d. per chain; dribble or rubble cost as follows:—digging stones per yard 1s.; breaking ditto 4d.; the drain filled a foot deep and 8 inches wide, will take $1\frac{1}{2}$ yard of stone per chain; filling and hauling $1\frac{1}{2}$ yard of stone $\frac{1}{4}$ a mile, 1s. 6d.; expense of making drain, putting stones in, and filling up, 2s., which is 5s. 6d. per chain; or with tiles $7\frac{1}{2}$ yards apart, 30 chain at 3s. 9d., 5l. 12s. 6d. per acre; with stones the same distance apart, 8l. 5s., a very considerable difference, and more than I had an idea of, for I never made a minute calculation before, as I only made between 20 and 30 chain of stone, which quite satisfied me I should not be able to drain the farm and keep other work up in any reasonable time without tiles; perhaps stones could be dug cheaper in some places than here, as they are here very rubbly and dirty, requiring a great deal of trouble to get them clean and fit to put in. I have compared this sort of stone-draining with tiles, because it is the one most generally in use in this as well as other districts, and by some thought preferable, but I consider tiles best.

Wall-drains are too expensive, except for mains, and for these, tiles are much cheaper. There was a considerable length of it done on my farm about 30 years back, which I am told cost 2s. 6d. per pole, or 10s. per chain; now contrast any of the above prices with that of clay-draining, which costs from 11d. to 1s. 4d. per chain, an average of 1s. according to the present price of labour, which will drain an acre for 30s., which is less by one-third than the expense of hauling tiles and putting them in, and drain 5 acres at less expense than one with stone. I have never seen a draining-plough for cutting out drains, but if it is applicable to any kind, it must be equally so for clay, to take the two top draws or cuts of soil out, but I think the tool above described must be used for the bottom slice, as that requires to be cut true to fit the blocks; but if the plough could be used to advantage I should not be surprised if some clay soils could be drained for 1l. per acre. Turf-drains are about the same expense as clay-drains.

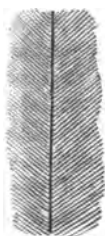
The next point is the direction of drains, the meaning of which I take to be the manner in which they are laid out, whether in the direction of the greatest fall, or obliquely to it, or quite across it; these have all their advocates, I am aware, but I have no doubt in my own mind, from the way in which I have seen drains act, that they ought to be made in the direction of the greatest fall for the following reasons:—first, because that is the quickest way to get the water off, and the water naturally perco-

lates through the soil in that direction; and a drain cut *up* the piece alters the direction of the greatest fall according to the steepness of the land. Thus:—

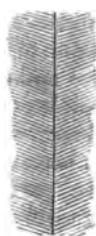
On Steep Land.



Land not so Steep.



Flat Land.



The fine strokes showing the direction in which the water enters the drains, *equally on each side*, which is not the case when they are made obliquely or across it. It is an old saying that you must go to the extreme in order to prove the medium; if that is not exactly the case you must go to the extreme to make the truth appear in its strongest light, which I will do as respects draining across the fall. Let any one go to a very wet piece of clay land on a steep descent and cut a drain the necessary depth up the greatest fall, then cut another out of that across the piece nearly on a level, just as the water will run off into the other, then notice how the water enters each of them, and which will dry the most land, you will see in the former the water will enter equally on each side, and at the bottom; in the latter it will come in only on the upper side, and that from the top to the bottom of the drain, forced in so by the weight of water above; therefore you find the land drained on each side of one but only on one side of the other, the lower side namely, as there will be none dry above; now from the water entering the drain in such a manner, all up one side, it may be necessary to fill *such* drains with something porous, as, if they were filled with tenacious soil, it would very likely conduct the water across the drain, and the drains be of little service, as they do not *draw* the water from the dried land below, but allow the land to dry itself from cutting the water off above it; if they act thus on steep land, it must be so in a measure on land that is flatter. I have seen where drains have been made across the piece at rather wide intervals, that in a wet time the water will run over them, and no one would know there were any drains; but after a little dry weather they will show by drying the land in their immediate neighbourhood rather quicker. Now I do not mean to say that land cannot be drained, and effectually, by cross-draining, but it must be more expensive, as the drains are required nearer together. There are a few exceptions to the above

rule, one or two of which I will mention; as where land has been ploughed in high ridges across the line of the fall, which is sometimes the case, not but it would drain better if ploughed up and down the greatest fall: but land in high ridges, as I have said before, is in a measure partly drained, though at the expense of the furrows. Another exception is where a spring breaks out on the side of a hill, where, perhaps, a single drain across the piece will make a cure; but it is not always that a side of a hill, wet below a certain point, is cured by a drain across; the best way to know whether a side of a hill can be drained with one or two cuts across the piece is to observe whether the top or bottom of the wet part gets wet first; if the bottom is wet first, and it gets higher up as the wet weather continues, then a drain across at top will be of little service; but on the other hand, if the land is not wet until the spring breaks out at top, then a single cross drain is likely to answer; you can also see that land is wet from springs, by the water's wasting away after it has run a little distance. I once made a clay drain with no outlet on a piece of land, a clay loam, that had a spring break out in the furrow. I began to cut the drain upwards from the point where the water wasted, and made it up through the spring: this drain kept the water underground and dried the land. There may be a few more exceptions to the general rule of draining down the greatest fall, which would require to be seen, as they are difficult to explain.*

Fall required.—According to my views there cannot be much said on this head, only to repeat, get the greatest fall. That different kinds of drains are best suited to different degrees of fall there is no question; hollow drains are most suitable for flat land, and very steep, and I think best for all land. Stone, wood, &c., may be used to best advantage where there is a moderate fall; where mains have but little fall care should be taken not to go too far without emptying them, or they may be liable to choke up; a fall from 1 in 60 to 1 in 100 is the best for making the most of the drains, for I find that steep land is more difficult to drain, or rather, requires the drains nearer together, than land of the same texture having a gentle fall. If my last made sketches are on correct principles, and I think this is a proof they are, for suppose the drains to draw the water each the same distance,

* I tile-drained a piece of clay-land, which is not quite effectual, by deviating from the above rule; the piece lies in an irregular form, some of it having a considerable slope two ways; it was ploughed in low ridges, and drained up the furrows, their fall being 1 in 11, and the greatest fall 1 in 8; and I find after heavy rains that close above the drains there is a portion of it wet; if subsoiling will not make them have the desired effect I shall be obliged to put in extra ones between.

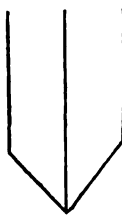
that on the steep-land, from its entering at very acute angles, will not drain so much land each side of it as where it enters at nearer right angles.

Disposition of Drains.—The drains should be made as before stated ; and, to guard against their choking up, never get much water together, which is not often the case in furrows, except where there is a considerable length of flattish land and a sharp fall towards the bottom of the piece, then I would have a main drain to take the water out of them before it went down the steep part, and then drain that by itself ; and if in the direction of the main there is but little fall, instead of making one main, I would let each drain empty itself in the open ditch, or two or three together ;

Thus :



Or thus :



which would obviate their liability to choke at the junction with the main. I am aware there are advantages and disadvantages of emptying each drain by itself. If any accident happens it only injures one and is easier found out and amended. On the other hand there are more mouths to attend to, and more chance for vermin to injure them.

Benefits from increased Crops admitting new mode of Culture and Stocking, advancing the time of Harvest, reducing the amount of Horse-labour on heavy Soils, improved Climate, &c., &c.—There is not the least doubt but that draining is beneficial under all the above heads, but somehow we farmers do not finish our experiments and improvements out, by comparing the produce and returns. We see and judge from the appearance of the crops whether such and such things answer, and act accordingly ; but when it is required to state particulars we are at a loss. Such is my case with regard to the increase of produce, but I continue draining on ; besides, the improved culture you are able to carry on *must* increase the produce and returns. The greatest and quickest return I *know* of was where part of a piece of land was furrow-drained with tiles by a kinsman of mine in the vale of Gloucester ; the whole piece was planted with barley, and the extra crop on the part that was drained more than paid the whole expense, besides the extra straw. Now if it had such an effect one

soils in wet seasons cannot always be worked as they ought, even if drained, so it is best to have tolerable strength when it will work well), altogether you cannot reckon upon more than one-fourth saving, which, however, is something considerable, as horse-wear and keep are expensive.

Improved Climate must naturally follow a well-drained country; where the excess of moisture is left to evaporate from the heat of the sun and fall again in the evening in fogs, a damp unhealthy atmosphere must be created, bringing agues and fevers in its train, but I think we do not hear so much of agues now as we did even 20 years ago, and I should say they have been prevented in a measure by the more effectual drainage of land, of stagnant pools, and of towns. In a work I have lately read it is stated that the average of life is considerably increasing; if this be correct, and we have no reason to doubt it, it is not too much to say that it is caused partly by an improved climate. But those who live in marshy or fen districts can say something more to the point under this head than I am able to do.

Some other advantages may be derived from well-drained land, to which I will call attention. One is the way in which the land should afterwards be ploughed if it lies in ridges. Such fields are generally ploughed, alternately cast, and ridged, that is, all the lands are cast down one time when they are ploughed, and ridged up the next time; by so doing you have the furrows open over the drains; but land is generally ridged up for wheat; and we all know that in finishing a ridge the cattle tread the furrow more than the other part; and, as wheat ploughing is often done when the soil is not very dry, they knead it down very close; and frequently after it is planted and ought to be finished, the farmers get three or four horses in length and plough the furrows out again, that they may also know where to hoe and reap to; but what can be more absurd? If the drains are only from 12 to 18 inches below the bottom of the furrow, under the idea of opening the ground to admit the water, they actually prevent it by the treading of the cattle; for water will enter a drain 30 inches deep with the soil left in its natural state, a great deal quicker than it will a drain of 12 inches where the ground has been kneaded down. Now, after I have drained a piece of land, if I wish to keep it in ridges, which I do where the lands are wide and on a clay sub-soil, I plough each land alternately ridge and cast, always ploughing the two lands that lie to be ridged, first, one on each side of the one to be cast. By doing so I have only one finishing-furrow to two lands, and that always on the top of the ridge, and they are generally plain enough to hoe or reap to without fresh striking. By this mode there is no more treading over the drain than over any other part, and a considerable amount in manual labour is

saved annually in not having to make furrows and water-trenches, which are quite requisite before the land is drained, though besides taking off the water a considerable portion of the best soil is washed off with it.

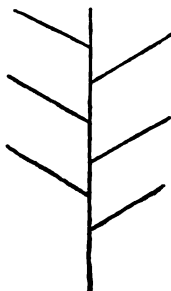
On land that is not drained wheat is very liable to lose plant through the winter from various causes; some is starved by the wet, some drawn out of the ground by the frosts from its being wet, and a considerable portion in some seasons never grows at all, as the seed will burst when the soil is very wet: 2 pecks of seed can be thus saved by draining, and yet a more regular plant be obtained. I have no doubt that I use so much less seed than I used to do on my own farm. A great deal more benefit is also derived from the manure that is applied; and there are many more, which perhaps by some would be thought trifling advantages; but, as a farmer said to me the other day, if anything is to be got in farming, it must be 5*l.* in one way and 5*l.* in another; it is of no use to make any great speculation, thinking to get 50*l.* as it is in trade, for profit can only be acquired by steady persevering industry.

Durability of Drains.—This must depend on the materials used, the nature of the soil, and the manner in which the work is executed; but I can see no reason why the generality of draining, if done well, should not be permanent, or at least last an indefinite number of years, provided accidents (to which everything is liable) are attended to in time and mended; a little neglect may soon damage a great deal of well executed draining. Stone, tile, and clay are likely to last as long as any; the two former from not being liable to decay, and the latter from there being nothing to decay; even wood draining has been known to last on some soils 40 to 60 years, but then no portion of the wood remained, the opening being formed into a clay drain; as wood must rot in a few years, and where the soil is not sufficiently tenacious to form an arch it must fall in.

The Past and Present practice of Draining is various in different parts of the country; the past practice in this neighbourhood was to use stone and turf; the stone for wall or rubble-drains, according to their length and the quantity of water to be taken off: they were generally put across the greatest fall to take the water from wet flat places, and to catch springs, which was all that was thought necessary. I do not know a piece of land that has been well drained so long as 20 years, but a great deal that had been partially drained. I have myself furrow-drained several acres that were considered to have been sufficiently drained by two or three large wall drains in 20 or 30 acres, which certainly used to carry off a tolerable quantity of water, but still open furrows and trenches were required to take off the rest, but now

no water runs off except by the drains. Rubble-draining is rather an ancient practice here for short lengths, and for tributaries to the wall-drains, but they are not generally laid out in the right direction, or put in deep enough; the following used to be a common way of laying them out, and is still carried on to a considerable extent; a drain is made up the piece, with arms branch-

ing off on each side, thus :



but it is not at all to

be recommended, as part of the branches are put where the land would be dry without them, that is at the junction on each side of the upright drain, and the other part, from being across the fall, will not act to the greatest advantage: the same length of drain made parallel with each other will drain considerably more land. I have cut across old *turf*-drains completely choked up with mould. They were rather shallow and I suppose had not been rammed, but made as before described, the turf being placed as a cover. I consider clay so much preferable to turf from there being no vegetable matter in it to decay. The present practice is not, as it ought to be, carried on upon the same system through the whole country, though the circumstances may be the same; a piece of wet clay-land in Cornwall ought to be drained upon the same principle as in Scotland and in all the country between: the distance of the drains indeed must vary according to the tenacity of the clay. I will recapitulate what ought, in my opinion, to be the present practice; the depth should be at least 30 inches, especially in tenacious soils, filled in with the soil which has been taken out; the distance to be ruled by the tenacity of the soil; the materials to be stones, tiles, or clay, to be laid out in the direction of the greatest fall at equal distances, except where the land lies in ridges, when they should be put in the furrows; but I would not ridge land up more than before draining, neither would I level that which has been before ploughed in ridges.

Districts in England which require the most extensive efforts in Draining.—To answer this question properly requires to have travelled more than I have done; still I have seen enough to satisfy any one (however much has been done) that there is a vast

extent which requires it, perhaps in every county (I am certain there is in Gloucester, Warwick, Worcester, Wilts, and Berks), which would pay a great deal more per cent. than the purchase of land; it may be very praiseworthy to reclaim bogs, inclose land from wastes or the sea, but what is the value of a few hundred acres more land added to the country in comparison with draining all the old tillage-land that requires it throughout England? why but as a mere drop in the bucket. I have no doubt that I speak within compass in saying that it would produce an increase of 4 bushels of wheat per acre, to say nothing of the increase of stock the land would be able to carry by improved culture of green crops instead of naked fallow, which is necessary before draining in order to keep it at all clean; therefore however beneficial reclaiming bogs and wastes, &c., may be individually, it is not to be compared, as regards the country at large, with the benefits to be derived from a general drainage of the clay and wet land already in tillage, and such is the description I should say on which there is the most room for extensive efforts in draining, but in which counties they predominate I am not prepared to say, though beside the counties above mentioned, I have seen an extensive district lying by the railway between Birmingham and Liverpool.

Perhaps I have not answered all, if any, of the different heads quite satisfactorily, as there may be some soils different from any which I have seen; but I am well satisfied that the principles above advocated are correct; and as regards clay-draining, I would not object to try any clay-soil having a proper fall, not receiving the expenses unless it answered the purpose. It has been tried on the clay adjoining the Thames or Isis, on that at the foot of the chalk hills in Wilts, and on the clay-soil in the vale of Gloucester, all of different species, though all very tenacious. I do say, from the manner in which a great portion of the draining is executed in this country, it is *quite necessary* for our Society to lay down sound, plain rules, stating also where these can be deviated from with advantage.

*Stratton St. Margaret's,
Swindon, Wilts.*

XXIV.—*Account of Improvements on Linslade Farm*
By W. G. HAYTER, M.P.

IN November, 1839, I took in hand a farm at Linslade, in the county of Bucks, of about 250 acres of convertible land, which had been for some years untenanted (the previous tenant having,

after a long continued course of bad management, failed upon it), and which had been held on by a bailiff put in merely to prevent it from falling into absolute waste until some opportunity of letting it might occur.

The capital upon the farm when taken in hand was computed and taken at 1000*l.*, and the annual value placed upon it, but which it was wholly out of the question, without a very considerable outlay on the part of the landlord, to obtain, and which, in fact, could not be obtained, was 250*l.*

The quality of the land was of a varied character, nearly one-half of the arable (the whole being about 170 acres) consisted of a strong clayey loam, and the other half of a light siliceous sand, but both very wet, and requiring extensive and thorough draining. The meadows (40 acres) were of the worst possible description, divided into numerous and capricious portions, intersected by broad and deep ditches, overgrown with sedges and other aquatic plants, and flanked with old and decaying willow-trees; they were at all periods of the year liable to be overflowed by a mill-stream which half encircled them, and the bed of which had been gradually raised by a long-continued deposit brought down by the sluggish river Ouzel, the boundary on this side as well of the property as of the counties of Bedford and Bucks.

The fields, as well arable as pasture, were unequal in dimensions, divided from each other by wide, overgrown, and irregular thorn hedges, the ready and constant receptacle of weeds and vermin. Upon the whole, the farm was much in the same condition as many others in that locality and in other parts of the country now are, although from its peculiar circumstances somewhat below the average.

In the course of three years, by an improved system of husbandry, by a greatly increased growth of green crops, and by a consequently increased stock both of sheep and cattle, an entire revolution in its character and prospects has been effected; and that which was one of the worst is now in the progress of being made, and when a set of farm-buildings about to be erected shall have been completed, will become one of the best farms for its size and situation in the county of Bucks.

Nearly the whole farm has been thoroughly drained, and the principal part of the arable land subsoiled and limed; indeed, more than sixty miles in length, both of tiles and soles, have been laid down. The fields have been squared as well as circumstances would allow (a curve of the Birmingham railroad passing through the centre of the property), the roads have been straightened and shortened, and the arable land has been divided into ten fields, each as near as may be of 17 acres, fenced with live quick hedges, and protected throughout by strong fir railing. The bed of the

river has been effectually cleared out by the removal of upwards of 7000 cubic yards of alluvial deposit, by the means of which the wide open ditches of the meadows were all filled up preparatory to the laying down of tiles over the whole extent of them, which has been effected. The meadows have been now completely drained, and by their abundant crops have already paid an ample interest upon the outlay. The cleansing of the river has also afforded the means of effecting a great permanent improvement in the texture and composition of that part of the arable land which consisted of a light sand, upon a great portion of which from 40 to 50 tons per acre have been carted.

The farm has moreover been amply stocked, and a regular course of husbandry adopted and laid down for its future management. Upon the strong land the course proposed is—

Wheat, followed upon a portion by tares, to be fed off.

Green crop, consisting of potatoes and turnips.

Barley.

Grass.

Beans.

Upon the lighter land—

Green crop, consisting as to one half of carrots, mangold-wurzel, and cabbages, and as to the other half of turnips.

{ Half wheat, after carrots, mangold-wurzel, and cabbages.

{ Half barley, after turnips.

Grass.

Grass, to be fed.

Oats.

On the 1st of November, 1842, the live stock upon the farm was as follows:—

46 head of cattle, of the improved short-horn breed.

317 sheep, principally the improved Leicester.

25 pigs.

10 horses.*

The value of the live and dead stock and growing crops upon the farm on the 1st of November, 1842, at the then depreciated prices, amounted to 3177*l.* 16*s.*

To what extent, then, has this outlay been carried? And has it or not been beneficial? This I will now proceed to show.

During the period of the three years to the 1st of November, 1842, in which the course of improvement has been proceeding, the total amount of the disbursements, including rent at 250*l.* per annum, interest at 5 per cent. upon the capital, together with

* At present there are 57 head of cattle, and 8 horses; but 7 horses, including a riding horse for the bailiff, will ultimately be adequate.

the salary of the bailiff, has been 8163*l.* 16*s.* 8*d.* The receipts during the same time have been 3079*l.* 9*s.* 7*d.* And the value of the stock on the 1st of November, 1842, was 3177*l.* 16*s.*, making a total of receipts and stock of 6257*l.* 5*s.* 7*d.*, and constituting an excess of disbursements over receipts of 1906*l.* 11*s.* 1*d.**

The result therefore is that, on the 1st of November, 1842, there had been expended upon the farm, beyond the value of the stock and crops, the sum of 1906*l.* 11*s.* 1*d.* This expenditure, however, was incurred with a view to the ultimate improvement of the farm, and to its increased value as property, and neither could nor ought to have been incurred by any tenant except under the security of a twenty-one years' lease, in which event it would have been a provident investment of capital.

In order to ascertain the actual position of the property consequent upon this expenditure, the farm was in the month of July last valued by an able and experienced surveyor, himself the tenant of a large farm in the immediate neighbourhood, and who, during the whole course of improvement, has been a witness to it, and from continued and personal observation is enabled to testify as to the correctness of the above statement. The annual value which he has placed upon the farm is . . . £ 344 0 0

† A small portion let off 12 0 0

† Three cottages and gardens 11 0 0

£ 367 0 0

Several applications have of late been made by most respectable persons to become tenants of the farm, and there is no doubt whatever but that it may be readily let at the above rent, or even at an advanced sum for a twenty-one years' lease; and if that be so, the result is, that an annual increased rental of 117*l.* has been obtained by the outlay of 1906*l.* 11*s.* 1*d.*, in other words, that land has been purchased (for permanently increasing the value of existing land is tantamount to the purchase of an additional quantity) at a price which will yield rather more than 6*l.* per cent. per annum upon the capital invested.

* Stock is taken regularly on the 1st of November in every year, everything is then valued as if at that precise period a tenant were to succeed taking off stock and crops. The very reduced price of all farm produce made a difference of nearly 20 per cent. upon the value of the stock and crops in November, 1842, and also in the subsequent estimated rental.

† These two portions are included in the original rent of 250*l.*

XXV.—*On the Agriculture of Spain.* By Capt. WIDDRINGTON,
R.N., F.R.S., F.G.S.

ALTHOUGH, from the great extent of the territory of Spain, and the vast variety of soil it contains, it would be impossible within moderate limits to give an adequate description of the agriculture of it, I have great pleasure in complying with the request made through Dr. Daubeny, of furnishing some data on this interesting and little known subject.

In my work on Spain, published in 1834, I proposed, after looking a good deal into the natural history, a division of the country into three great zones or divisions, as marked out by the hand of nature. On more mature reflection and observation, I am more and more inclined to adhere to this arrangement, and I now advert to it because it assists most materially in judging not only of the natural but the artificial productions of the earth. The first division is that of the territory lying along the Mediterranean at the foot of the Sierra Nevada, and the great secondary ranges of mountains which extend with hardly any interruption from the western extremity of the Peninsula to the Pyrenees. In the whole of this comparatively narrow district, to which I have applied the name of "tierra caliente" (warm land), little wheat or even barley is cultivated. The soil in most of the finest and most highly cultivated parts, as the Huertas or gardens of Valencia and Murcia, is naturally poor and arid, and owes its exuberant fertility to the hand of man, by irrigation, of which, amongst the finest, if not the very finest, works in the world are those of the Moors, which still remain unaltered in the hands of their descendants.* In some spots, principally at the mouths of the rivers, better soil is found; and in some places, especially in the sugar grounds of Motril and Almunecar, it consists of vegetable mould and detritus constantly brought down by the melting of the eternal snows above them. The Vega of Malaga is fine loamy soil, and in it wheat is chiefly grown. In general, in this district the productions are extremely varied. Besides oil, wine, and silk, pulse of various sorts, lucerne (cut in some places twelve times in the year), rice, sugar, piminta or red peppers, batatas (*Convolvulus batata*), cotton, even coffee has been tried with partial success. The cochineal insect is easily raised at Malaga and other places, and the chirimoya, a tropical fruit, perfects its fruit in the open gardens at Motril. The

* They consist of large artificial reservoirs of water, which are public property, under the control of persons specially appointed for their care and management. At certain appointed times the ducts of these tanks are opened, and the water allowed to pass over the ground of those landholders who have a right to the immunity.—F. BURKE.

sugar plantations are increasing, the proprietors having benefited by the abrogation of the tithes. Notwithstanding the surpassing fertility of a part of this district, the far greater part is a dry and arid desert, as far as agriculture is concerned, vast tracts producing only the most fragrant and beautiful wild plants in Europe. The establishment of pantanos or reservoirs to collect the winter rain, in the mode of those of India, for which there is great facility, would produce extraordinary change in the face of this most interesting region. The principal food of animals in some parts is the pod of the algarroba, or locust tree (*Cercis siliquastrum*), which grows in the most arid soil, but the value of it is almost exclusively known to the Valencians and Catalonians, whilst, from the want of better animal food, baccalao or dried cod fried in oil is a staple article in that of man. It is not eaten in compliance with the ordinances of the church, the people of the whole of Spain being exempt by special bull from the ordinary fasts of the Roman catholic church, but as a regular standing article of food, and in most of the villages the traveller can procure little else. To show more clearly the nature of the line I have drawn as to the climate, on the 20th of May they were in the middle of the wheat harvest in the Vega of Malaga, whilst in that of Granada, which belongs to the second division, a fortnight afterwards the corn was perfectly green, and there was nearly a month difference from that and the "tierra caliente" only a few miles distant.

The second region is by far the greatest in extent, in value, and importance, in every way, of the Spanish peninsula. It comprises the two Castiles, Aragon, Estremadura, the greater part of Catalonia, Upper Andalusia, and part of Navarre and Leon. From the products of the greater part of it, the term 'cerealian' may be applied to it with great propriety. Throughout its vast extent wheat is produced in quality, and would be in quantity if it were properly tilled, equal, if not superior, to that of any country on the globe. The better parts of this division are the two table-lands of Old and New Castile,* with the territory of La Mancha and of Cuenca, the territory of Guadalaxara, the Alcarria, a district near the sources of the Tagus, that of the valley of the same river above and below Talavera, the province of Toledo. In Old Castile the territory of Olmedo and Palencia, of Burgos, of Medina de Rio Seco, and most parts of the course of the Duero and its tributaries.

The kingdom of Leon, with its noble streams of the Esla and

* The greater part of the Castiles is almost entirely arable, producing remarkably fine wheat, from which is made throughout Spain, some of the best bread in Europe. The country is mostly bare of timber, and rises imperceptibly to Madrid.—F. B.

others, has a great deal of admirable soil, and also belongs to this division, its northern part running into the third region. Estremadura, which would form a respectable kingdom of itself were it cultivated, is upon the whole the finest province in Spain; nearly the whole of the soil is fertile, and only the noble mountains, which ought to be covered with timber and grazing grounds, are not capable of producing the cerealia in the greatest perfection. The richest parts are the valley of the Tagus, the territory of Caceres, that of Merida, and of the Lower Guadiana.

In Aragon, the country on both sides of the Ebro, which nearly divides it; that of the Xalon, the province of Molina, and many basins and alluvial districts on the streams which rise in the dreary mountains, and form too large a portion of this kingdom.

In Catalonia, the plain of Urgel, not the Seu, which is in the Pyrenees, but a flat not far from Barcelona, lately irrigated by a canal of considerable extent, the country on the Llobregat and other rivers, where, as in Aragon, small tracts of extreme fertility are cultivated and often irrigated, whilst, like the adjoining province, great part of this is formed of dry and arid mountains.

In Upper Andalusia we have the beautiful Vega of Granada, the Lomo de Ubeda, a large tract of surpassing fertility near the sources of the Guadalquivir, the plain of Jaen, which formed a kingdom in the time of the Moors; Western Andalusia, resting on the Serrania de Ronda, also belongs to this division, and parts of the course of the "great river" (so called by the Moors), especially the territory of Cordova and Ecija: in this vast extent of territory there is every description of soil; but the predominant parts are clays (barro) of different qualities, loam, sandy loam, calcareous loam, red and other marls, and small quantities (near Salamanca and other parts) of sand. The soils of the Castiles are in great part sandy loam and clays, some of them (near Madrid) rather unfertile. The Alcarria and Guadalaxara chiefly consist of red marls and sandy loam; that of Aragon contains all sorts, but there is a great deal of sandy loam and red marl; Estremadura has marls, sandy loam (predominates), and barro or clay. In Leon the prevailing soil is sandy loam. In Catalonia red and blue marl is the most abundant soil, but others are found amidst its varied and mountainous tracts.

The third region is that of the north, and comprises Galicia, Asturias, the Basque provinces, and the greater part of Navarre. The vicinity to the Atlantic, the formation of the mountains, and other circumstances, produce abundance of moisture; and as the first division is characterized by the want of it, so is this by its superabundance. This region has also its characteristic, natural as well as artificial, productions, and the maize or Indian corn in great measure replaces the wheat of the great middle division.

As the distinction of the two first divisions was pointed out at Granada, so may this by the effects of difference of climate in the seasons. Whilst the spring and early summer in Estremadura this year were the finest known for the last ten years, and every description of crop was teeming in abundance ; in Galicia, up to the middle of July, they had had only the most cold and inclement weather, and were under the most serious apprehensions for the maize crop, on which, as on the potato in Ireland, the mass of the people depend for subsistence.

In the first region a great portion of the work is done by manual labour, the comparative smallness of the ground in occupation, the nature of the productions, and the dearness of fodder, causing that mode to be the most generally resorted to. As the intense heat only requires a supply of water to cause an exuberant vegetation, the quality of the soil is of less consequence ; in this it resembles some of the finest parts of Italy, which owe their seeming natural fertility to the same cause. The waste consequent on their constant and exhausting crops is readily supplied by the manures, of which all the descendants of the Moors, the inhabitants of the greater part of this division, are perfectly aware of the value, and take pains in collecting and applying. In this division few animals are kept, and still fewer bred. Small and inferior horses and mules, and asses of very superior size and make, form the principal part of the labourer's live stock.

In the second region, wheat, which is always of the finest quality, forms the staple food of man of every rank ; barley that of the horses and mules ; rye is much cultivated, principally for the use of the bullock. Besides the cerealia, wine, oil, pulse of various kinds, are produced in unlimited quantities ; whilst in the scanty remains of the magnificent forests which have been swept away by the ruthless management of a barbarous government, we yet find vast herds of swine, producing meat of a quality unknown elsewhere.* In this district also are the pasturages, both summer and winter, of the merinos, and other breeds of sheep, which even now would produce ample revenues were they properly managed. In this, as in every other division, are enormous tracts of land known under the emphatic term of 'despoblado' (unpeopled). Much of the finest land in Spain is in this situation, the towns and villages having disappeared within the last two and three centuries. In the province of Toledo alone forty towns are said to have disappeared since the time of Philip II., the greater part of which were places called "of labradores" (farmers or agriculturists) from their

* They are fed upon the sweet chesnut and fruit which fall from the trees, and afterwards fattened, when upwards of a twelvemonth old, upon Indian corn ; for porkers are never killed ; but sucking pigs are a favourite dish. The bacon, or *Tocino*, is detestable, but the hams are very fine.—F. B.

population being exclusively concerned in agriculture, of which description the greater part of the small towns and villages in the interior are.

In Estremadura the rich barros or clays of the lower Guadiana are, I believe, for I have not examined them, silt or warp. These lands are of such surpassing fertility that, with a little manure, they bear successive crops of the finest wheat, yielding twenty-five to thirty and even fifty fold return for thirty or forty years in succession, nor with care does it appear necessary ever to change the crops—although it is done in a small degree. In a vast many districts, especially where the want of population and of the means of transport (though this last want is now daily diminishing by the making of roads) cause a comparatively small demand for wheat, the wretched plan is followed of taking one crop and letting the land lie fallow for the next two years. In others, where the demand and supply are greater, they substitute beans or garbanzos; and in some with barley, and beans or vetches, the land is kept in constant cultivation. In all parts of Spain, the waste and desert appearance is partly caused by the vast extent of the common lands belonging to the towns and villages, the system of management of which is ruinous in the extreme, and the finest districts, capable of enriching the proprietors and the country at large, are abandoned to, and only serve as pasture for goats, sheep, or a few asses.

The garbanzo (*Cicer arietinum*), a coarse pulse, nutritive, but heavy and difficult of digestion, forms an ample part of the product of this region. It is deep-rooted, and in some parts they reckon it an exhausting crop, but in others not at all so. I was assured, that in some places it brings saltpetre to the surface, and in so great quantity as to be prejudicial. Can this be? If so, it cannot be the natural excretions of the plant, but must surely be extracted from the subsoil, and given out again, as it were, mechanically, merely passing through the plant.

In almost every part of this region that I have noticed, the crops of rye are very scanty, nor can I assign a reason, unless it be the practice of sowing in spring which is generally followed. They do not consider that it exhausts the soil. It is used almost entirely for the food of bullocks in this division. They admitted when I urged the point, that the comparative small value of the straw and of the grain would enable other grain to be advantageously substituted for this, which I was very much surprised to find so much cultivated in this noble region.

Most parts of this cereal region produce oil and wine in the greatest perfection, but both are badly managed, and the latter is not only little attended to, but the worst mode of preparation followed. Very little is consumed by the people themselves, few of

whom drink anything but water, and there is no demand or means of transport to any distance. There are parts of Old and New Castile, of Aragon, and of Estremadura, of which the names are unknown out of their own immediate locality, where the most wholesome and delicious wines are made, and could be improved so as to excel probably those of any other country. The most extraordinary sight I ever witnessed of this kind was the vineyards between Olmedo and Valladolid, this year; such was the abundance that they had the only resource left them in such a season, of throwing away all the old wine to fill their vessels with the new.* The prunings of the vines are almost the only fuel they have in some places, and are consequently of some value—often more so than the wine itself.

The most extended cultivation of the olive is now in Upper Andalusia and the valley of the Guadalquivir, where it is increasing most rapidly, owing to the demand for their fat rich oil in France and England as well as a great increase of internal consumption. It is becoming a vast source of wealth both to individuals and to the nation, the returns being certain and the lands by no means injured, but the contrary, by the plantations which are in open order.

In the third or humid region, the system, both natural and artificial, is quite different from that of the others, the staple food of man being maize; the cultivation of it is the principal object; it is generally raised by manual labour. In the higher parts of the country, especially away from the coast, rye-bread is substituted for it, and is almost exclusively used for the purpose. The domestic animals are fed with hay, other forage being scarce, and in some places to be had with great difficulty. Here only in Spain is anything like a dairy system to be found, and at Oviedo they have improved so much that the butter is as good as the generality in England.

Little wheat is grown, and in consequence of the want of communication, this grain, which is often unsaleable in Old Castile, bears a very high price in Asturias, only a few leagues distant, exactly as it appeared in the reports on Ireland a few years since.

The animals principally used in this region also differ from those of the others. The bullock, both for ploughing and drawing their antique cars with revolving axletrees, causing the valleys to ring with their creaking noise, is substituted for the mule. Notwithstanding this rude and primitive mode of conveyance, there is no doubt that in point of economy the inhabitants of this division

* Some of the finest red wine in Europe, the *Val de Peñas*, is grown in La Mancha. It partakes of the flavour and quality of both claret, port, and Burgundy; but, being in the heart of Spain, the expense of carriage is too great to bring it here.—F. B.

are further advanced than those of the richer regions of the south and centre.

Besides the important difference in climate as before mentioned, there are others of not less consequence—some resulting from it, and others unconnected with it. The quantity of herbage and the facility of making hay is one great difference; the hills are as green as those of these islands, and the country is divided into small allotments, the people residing much upon their properties; whereas in the central and greater part of Spain they live almost wholly in villages and towns, whence they sally out to work in the neighbouring fields. Whilst in some of the finer parts of Spain the country is desolate from the immense extent of the properties, and the supine neglect and ignorance of the proprietors, who live in idleness—not in luxury, but in poverty, in the capital, some parts of the division we are speaking of are suffering to a great extent by the too minute subdivision of land, resembling—excepting that they are proprietors—the state of parts of Ireland. Whilst the abrogation of tithes and the substitution of a direct tax for the payment of the clergy have in the great cereal region been a very great benefit to the holders and occupiers of land, in the moist or verdant country it is the reverse: and the difficulty of realising money for the payment of the priests is so much greater than that of the mode of payment in kind, which worked lightly, that they complain heavily of the change.

In every part of the country regions the instruments of agriculture are of the rudest description. They rarely plough deep enough, and in most provinces do little more than scratch or harrow the surface. The soil and climate compensate for this in ordinary years; but droughts are fatal, from the roots being too near the surface. The best implements are those used in manual labour; and they well know the use of them. In the Basque Provinces, where the population is nearly the most dense to the acre in Europe, they use a peculiar grape or fork, with prongs and short handle, all of iron. Each person has two of these; and they strike them into the ground—standing in line four or five together, then raising the slice together, it falls just like that from a strong plough. This, as they perform it, is very laborious work. In general the mattock is much used, and in no part of the world do men work harder than in nearly every part of Spain when their energy is called forth.

The situation of the agricultural classes requires to be noticed. There are four great divisions of landed property—that of the church, regular and secular, of which more than one-half has been sold, and the remainder is on the point of following. I believe the whole of this amounts in value to not less than 30,000,000 ster-

ling, of which 12,000,000 remained in June, and were calculated to produce 24,000,000, or double the estimated value, as the sales on the average do. The property of the secular clergy, most of which is now on hand, is supposed to exceed that of the monks. The portion sold has been divided into 150,000 lots; but this includes the fincas or town properties. The next is that of the great landed proprietors, which, although a few of them have a very large extent of lands, the produce of intermarriages amongst the families, with a view to aggrandise themselves—one of the many fatal errors in the Spanish system—yet they bear an insignificant proportion to the aggregate value of the territory of the whole country. Next come the lands of the lesser nobles and other possessors of land, down to the small freeholder. There are no data for ascertaining the quantity of land held by these, but it is enormous, and in general is much better managed than that of the preceding classes.

The fourth and last class, which, as far as I know, has been wholly overlooked by the writers on Spain, is the common lands belonging to the towns and villages. These are of most enormous extent, and affect the whole agricultural polity of Spain. They form the basis of the maintenance of the labouring classes and those a little above them, the produce of their hired labour being in addition to the help obtained from this source. They are a principal cause why the system of permanent service hardly exists in the country: almost in every part the agricultural labourers are nomade—returning home after a period of engagement for particular work, according to the season. In some parts they move at seed-time—in others for the vintage—in some for the winter's ploughing, &c.—and vast numbers make long periodical voyages with cars at the time the bullocks can feed by the road-side, carrying salt or other commodities to exchange for corn. The larger private estates are managed almost entirely by factors, who with the peasantry draw the greatest value from the land—the owner having to pay its vast accumulated charges, the only certain taxation in Spain being that drawn from the land, which is literally groaning under the weight of successive wars and wretched financial management. Notwithstanding the causes I have enumerated, and others, there is a slow but steady improvement visible in almost every part of the country. In despite of the civil war so lately ended, land is of more value than at the commencement; and in very many parts, especially in the newly-purchased properties, great improvements are making.

In some parts farming is carried on upon a scale as extraordinary as many other things in this singular country. There are many men in Lower Andalusia who have 100 pairs of bullocks; some have 200 and 300; and one, I was assured, had 800 yoke

and 150 pairs of mules ; and this year the seed he sowed amounted to near 10,000 English bushels of wheat and 3000 of barley ! For one extraordinary contribution during the civil war he was taxed at 16,000 dollars—3,000*l.* or 4,000*l.*, equal to double that sum in this country. One of them lately took the whole Andalusian property of the Duke of Medina Celi, amounting to thirty-four estates of different sizes. This is too vast for one management, and he sublets them ; but it is obvious this plan must retard improvements. The Duke of Ossuna, another grandee, who has estates as large if not larger than those of Medina Celi, by residing abroad has acquired more knowledge than the great proprietors are in general possessed of, and has commenced the system of letting small portions of land to the labradores, or cultivators, in his villages. This has answered so well that there is little doubt of its being followed up by others ; but the former nobleman has incapacitated himself from doing it by letting his whole property for twenty years to the individual above mentioned.

With respect to the stock, the only cattle as yet to my knowledge imported are from Galicia, where the best draught bullocks, after a certain age and servitude, and good keep, have improved so as to give a profit to the owners ; they are disposed of, and replaced by them with others of less price to undergo the same routine. The ports where they are embarked are Coruña and Vigo. I saw some of them, which came to this country in July, and were fine animals, but decidedly inferior to some I saw of the Estremadura breeds in the Sierra Morena in May. It was soon found that the inferior animals would not pay the expense of transport, and at present only those of the first class are selected. The vice-consul at Vigo, a Spaniard, a wealthy and most active and intelligent man, told me he was so fully aware of the advantages to be derived from the trade, that he had been instrumental in purchasing one of Mr. Bates's bulls and a cow at a high price, in order to avail themselves to the full extent of them, by producing animals of a higher class. 'I had long been struck with the beauty of some of the races in Castile and in Andalusia, as they are seen at the bull-fights, whilst tried and found wanting for the noble sports of the arena, and after they have been engaged in the more tranquil labours of the husbandman. I have no doubt that some of these breeds might be crossed with our own to great advantage. They differ in almost every district, and especially where the bulls are known, each proprietor keeping his own exclusive stock with Spanish jealousy : but this is not in general the case with the oxen, and abundance are to be had of excellent shape and qualities. The bullocks I saw at Vigo cost about 10*l.* each, to which the freight and duty are to be added ; but some I saw in the Sierra Morena were much finer, and might have been had for 6*l.* For

these there is a longer distance to travel, and then the serious inconvenience of the greater length of voyage. I apprehend nothing but steam will ever answer for this purpose, nor will our navigation be complete for this and many other uses, until by the Archimedean screw, or other simple propeller, and machinery to take up little room, and the help of sails, these voyages can be made at little cost. Nearly every superior race of animals we possess is exotic, and the result of judicious crosses with the native breeds; and there appears no reason why the cattle of Spain should not in our hands attain even greater excellence than in those of their present proprietors, with their scanty and insufficient pastures. There is no doubt that our dairies might be improved by the cows from Gruyere, and the mode of making butter by adopting some of the plans followed in those of Holland, where the best butter is cured in the heat of summer, at which period we cannot effect it.

With respect to the cattle from Estremadura, they should be purchased in the neighbourhood of Badajos, and probably Merida, at the end of May or beginning of June, and driven to Ayamonte, or some place on the coast, for embarkation. Those of Lower Andalusia, where vast herds are bred below Utrera, and at Medina Sidonia, would probably be better embarked at Cadiz or in the vicinity. A curious ground for observation on the results of feeding these animals will be the effect of moist and succulent food during summer. In the vast tracts they roam over, in the southern and central districts, the forage is extremely dry and scanty during that period, the water forming a great part of their subsistence. It is by no means improbable it may lead to a great and permanent improvement in them.

The laws respecting the Mesta or Merinos are still in force, but the proprietors of the lands over which they have a right of pasture are daily finding out methods of curtailing the nuisance and loss this absurd mode of protection of a particular branch has entailed on the whole country. I have not the least doubt that, before any long period elapses, the whole system will follow that of the convents and be numbered with the relics of past ages. There are two points to attend to in this important question. The pasturages of Estremadura, which serve them in winter, will require other stock, whilst those who live in the lofty mountains between the Castiles, where the sheep cannot remain in winter, must find the means of providing them with winter quarters nearer home. This I conceive there would be little difficulty in managing. They begin to *talk* of turnips and other winter provender in different parts of Spain, but any considerable change from ancient routine is yet far distant. The most important alteration I observed was the partial introduction of hedges and en-

XXVI.—*On the Construction of Cottages.*

By the Rev. COPINGER HILL.

PRIZE ESSAY.

I TAKE for granted that the Society desires to encourage the erection of cottages, in which due regard to the comforts of light, space, warmth, ventilation, and freedom from damp, are made to coincide with a fair interest on capital expended.

Cottages are too much in the hands of speculators, who exact an exorbitant rent for very inferior accommodation. The owners of estates are deterred from erecting them by dread of the expense: feeling that they cannot demand and take from a poor man such a rent as would repay them for their outlay. If I should succeed in inducing gentlemen of landed property (by pointing out an economical mode of building comfortable cottages) to turn their attention to the subject, I shall be amply repaid for the trouble of furnishing the required information. Now being myself owner of a considerable number of rural cottages, rented on fair terms, I am able to say, from the experience of several years, that the rents are paid with as much regularity as the Government dividends; and that the total loss upon twenty-five cottages in twelve years amounts to less than 20*s.*: so that persons need not entertain any dislike to this description of investment, from the difficulty of collecting the rents; and I trust, by the time I have finished this article, they will be also fully assured that cottage-building is not altogether an unprofitable investment of capital.

I have prepared estimates, item by item, for various kinds of cottages: such as walls of brick, or stud-work plastered on both sides; roofs of sawn timber, and slate or tile; cast-iron window-casements, &c.; but upon reconsideration I abandon all of them but two, which are especially suitable to rural purposes. Of these I shall give a detailed account, so that gentlemen may be their own architects, employing only journeymen tradesmen, and purchasing their materials at the usual retail price: I do not mean the price at which they may be got by the trade, but that at which any person may buy them without indulgence from the wholesale dealer.

The space I consider necessary for the accommodation of a rural labourer's family is—a dwelling-room, about 13 feet square; a pantry or cellar, about 8 feet by 13, including the stairs and a closet under them; and two bed-rooms over these.

The outer door should open into the dwelling-room, instead of making the pantry a sort of entrance-hall, as some recommend.

The light required for the dwelling-room is furnished by a window 3 feet 6 inches by 3 feet, and should be placed near the fire-place, in order that the housewife may have the advantage of the declining light as long as possible, while seated at her needle. The bed-room and pantry windows may be 2 feet 6 inches by 2 feet. The dwelling-room windows may be fixed;* the others require an open casement. Ventilation requires a height of 8 feet below stairs, and 6 feet 4 inches above: the height will be 15 feet, including the floor. I do not like the low, thin-walled, slated cottages one sometimes meets with in gentlemen's grounds. A bed-room on the ground floor, especially on a clay soil, is not desirable.

Warmth and dryness cannot be ensured unless the walls are 14 inches thick; or 9 inches, and battened within; or stud-work, and plastered on both sides.

The aspect, if possible, should be a point or two to the westward of south.

In large towns there is little choice of building materials: brick, and slate or tile, are necessarily used, and foreign timber; and where houses stand thickly, durability and warmth may be consistent with 9-inch walls and slight carpenters' work; but in the country it is not so: there we have a variety of materials, and to rural cottages I shall chiefly confine my attention.

Moreover, a different kind of accommodation is required in town and country. In the former there is no occasion for ovens, or cellarage, or large pantry, and but little for coppers: the chimneys and fire-places, and the entire building, may consequently be on a reduced scale.

The cost of cartage in the country is small, compared with what it is in towns: and here I would observe that all my estimates are exclusive of carting, and give the money price paid within six months.

On the whole, I recommend a cheap material for walls, such as stone or clay, in preference to brick or stud work, as well on account of warmth as that the builder may not be tempted to stop short at 3 feet perpendicular height of wall on the chamber story, and gain the required height by means of a coved ceiling.

I recommend also straw, or reed, or sedge, as a covering, both from the uniform temperature preserved by them and their reasonable cost. No one who has not experienced it can conceive the discomfort of a cottage covered with tile or slate. Ask the inhabitants, and they will tell you what they suffer from heat in

* Every inhabited room should, I think, have a window to open, and a fire-place. An air drain round the building is, in damp situations, highly useful.—BRAYBROOKE.

summer and cold in winter.* A thatched roof (the straw being threshed by the flail, and not by machine) will last thirty years or more, being once "roved" or "ridged," at a trifling cost, during that period. In the meantime the difference in prime cost between slate and thatch will have accumulated sufficiently to pay for a new roof.

Cottagers like to have things to themselves. There must be no common oven or copper; neither is it necessary to have the oven or copper in a distinct apartment from the dwelling-room. The mother of a family can attend to the children while she is "washing," or "baking," or "brewing," if these operations are carried on in the dwelling-room, but not otherwise.

The chimney must be an open one, $4\frac{1}{2}$ feet in the clear, and the jamb must be 2 feet $1\frac{1}{2}$ inches deep. The back of one chimney, which is the partition between the two, must be 9 inches: thus the base of the double chimney will be 5 feet by 6 feet, outside measure, having the mouth of the oven on one side of it. The copper, which is a tenant's fixture, may be beside the oven. The grate is also a tenant's fixture, and so are the shelves.

Leaded casements are the most usual in cottages, but they are cold and fragile. The square form is more desirable than the diamond. Cast-iron are neat and durable: they may be of any form, diamond or square, but they are expensive. Wooden are cheaper than either of the above.

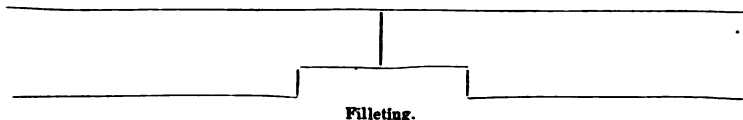
Stone-work, 14 inches thick, and rendered inside with lime-mortar, is warm and durable, and well-looking; and in those districts in which stone may be had for little more than the raising, can be employed to advantage. Clay walls made in the manner I shall describe, and protected by thatch, are as warm almost as durable (quite, says Mr. M——, steward to Lord A——), and, with a little timely attention to repair, look as well.

The ceiling may be either of lime-mortar or of clay. The former I should adopt, if the walls are of stone; the latter if of clay. But of this hereafter. Sometimes the ceiling is between the joists, by which a saving is effected, as less materials are required than for ceiling over the floor-joists, but the plan is not a good one. Dust is apt to fall; and, moreover, joists of the scantling I recommend require to be "stayed" between by short pieces of wood, placed zig-zag; and ceiling between the joists would expose these to view.

All ceiling may be dispensed with by "filleting" the floor-boards, *not* rabeting. In filleting, the under edge of each floor-board is cut away, and a fillet one inch wide, and three-fourths of

* From long experience I have found slate roofs far preferable to any other covering for cottages and barns. Thatch soon perishes in Essex.—BRAYBROOKE.

an inch thick, is introduced. This plan prevents the dust from falling, but exposes the "stays." Neither this plan nor ceiling between the joists is worth adopting, in my opinion. Filleting is excellent for granary-floors.



Clay for building should be a clay-marl. If the clay is not good, chalk and road-grit should be mixed with it. The proportions of clay and chalk may depend on the goodness of the clay, and the facility of procuring chalk. With moderate clay, say seven-tenths clay, two-tenths chalk, and one-tenth road-grit.

The clay and chalk are raised and carted to a convenient spot of hard ground, where they are beaten to pieces by a heavy prong, and the stones picked out, and formed into a circular bed 1 foot thick, and 20 feet diameter.

The bed is well watered, and trodden by horses; and, while trodden, one man shakes short straw upon it with a fork, while another pulls it about with his prong, and throws the outside portions under the feet of the horses, and supplies a sufficiency of water. It can hardly be too much trodden. The clay-dauber's joke is, "You spoil it, if you tread it too much." A small cart-load of straw, or the buck of a waggon-full, may be used to such a bed as I describe. It is then rounded up, and covered with straw till wanted for use. When used, it is somewhat moister than brick-earth prepared for moulding.

A pinning of stone-work 14 inches thick and 1 foot out of the ground is prepared; the clay is carted and laid in heaps beside the pinning. One man gets upon the pinning with a small three-tined fork; his partner throws up to him small lumps of clay, the size of a double-fist, which he adroitly catches on his fork, and deposits smartly on the wall, walking backwards. A height of 20 inches or 2 feet is built at one time; at intervals, as the work proceeds, the workmen coax the sides of the wall with their tools, and get it straight and erect: it is then left to dry for a few days or longer; all depends on the weather. When sufficiently dry another course is laid on till the requisite height is obtained. As the wall rises, window-frames and door-frames are fixed; and when the roof is on, the dauber with his trowel cases the wall inside and out with clay, corrects all defects and irregularities, and leaves it smooth and white. The clay for casing is prepared with more care than for the body of the wall: old clay-wall worked up afresh makes the best casing.

The wall so built retains its fresh appearance for very many years under thatch, and when repair becomes necessary may be renewed again at a cost of 3*d.* per square yard, all expenses included; and the second coat is as durable as the first. The writer has clay walls covered with thatch, which have been thus repaired within a few years, after standing forty years. Sometimes the casing of a new wall is delayed for a year. Some persons, Dixon among others, recommend rough-casting these walls with lime-mortar; but that plan fails—the rough-cast soon comes off.

If it is wanted to carry walls up a considerable height in one season, clay-bricks 20 inches by 14 inches, and 6 inches thick, must be formed and dried in the sun for a portion of the wall: these may be set in clay-mortar at any period of the erection. A very excellent parsonage-house has been built in this way. The clay is worked, the wall built and faced complete, for 1*s.* per square yard and beer; 2*s.* 6*d.* in the pound is allowed for beer in all trades on the amount of labour, which will bring the square yard of clay wall to 1*s.* 1½*d.*; add thereto 1½*d.* per square yard for raising clay or chalk (chalk-rubbish may be had at the lime-kilns gratis) and sweeping up road-grit, and 3*d.* per square yard for straw, and the total cost of 1 square yard of clay-wall is 1*s.* 6*d.*, exclusive of carting and the use of horses. The straw used is the short wheat-straw thrown out of the barn, fit only for littering the yards, not good enough for thatch or the riding-stable. This wall requires no further plastering inside to make it fit for occupation.

In estimating the cost of stone-work I shall put the stone at 1½*d.* per bushel, that being the price it is sold for hereabouts; the cost of throwing out building-stone from the gravel-pits is 12*d.* per score bushels only: but I fix the price of 1½*d.* a bushel, because stone is a saleable commodity, which clay is not; but where stone is plentiful it may almost be taken like clay, at the cost of raising it.

A rod of 14-inch stone-work requires 200 bushels of stone.

	<i>s.</i>	<i>d.</i>
Cost of stone per square yard	0	10
Lime 1½ bushel, do. do. at 5 <i>d.</i> per bushel	0	7½
Sand 1½ do. do. do. at 1 <i>d.</i> do.	0	1½
Labour and beer	1	1½
	<hr/>	
Cost of a square yard of stone-work	2	8½
	<hr/>	

But in the stone-work of this neighbourhood the corners of the house, and the sides of the doors and windows, must be brick; the additional cost per square yard on this account will be near

enough for our purpose at 4*d.* Thus the total cost of stone-work is 3*s.* 0½*d.* per square yard.

In a double cottage, each containing the accommodation above stated, the outside measure will be 50 feet in length by 15 feet in width, by 15 feet high.

A double chimney in the middle requires 1600 of bricks at 3*s.* 4*d.* per hundred.

	£.	s.	d.
Cost of bricks	2	13	4
16 bushels of lime, at 5 <i>d.</i>	0	6	8
16 do. of sand, at 1 <i>d.</i>	0	1	4
4 lbs. of hair, at 2 <i>d.</i>	0	0	8
Labour and beer	1	2	6
	<hr/>		
Cost of chimney	£1	4	6

N.B.—Hair is bought at the tanners' at 16*s.* per 112 lbs.; but I put it at 2*d.* per lb. in these estimates.

One oven sufficient to bake 3 stones of bread requires—

	£.	s.	d.
500 bricks, at 3 <i>s.</i> 4 <i>d.</i>	0	16	8
5 bushels of lime, at 5 <i>d.</i>	0	2	1
5 do. sand, at 1 <i>d.</i>	0	0	5
½ lb. hair, at 2 <i>d.</i>	0	0	1
Labour and beer	0	14	6
	<hr/>		
Cost of one oven	£1	13	9

Cost of two ovens 3*l.* 7*s.* 6*d.*

One hundred cottage paving-bricks will do more than 3 square yards, at 4*s.* 7*d.* per 100.

	s.	d.
Cost of bricks for 1 square yard	1	6
„ sand	0	0½
Labour and beer	0	4½
	<hr/>	
Cost of 1 square yard	1	11

Cost of paving about 61 square yards, 5*l.* 16*s.* 11*d.*

A skirting will be required: it may be made by means of old thin paving brick set on edge, against which the flooring bricks are laid. About 130 feet in length of this work will be required, as it is not necessary to skirt the partitions, the pinnings of which are of 4-inch brick-work, and may cost in all 6*s.* If old bricks cannot be procured the brick-maker will readily make a few tiles of the best material for the purpose.

Skirting, 6*s.*

One bunch of ceiling-lath, which costs 1*s.* 9*d.*, will cover 4 square yards.

	<i>s.</i>	<i>d.</i>
Cost of lath per yard	0	5½
Hair, ¾ lb.	0	1½
Nails	0	2
Lime, ¼ bushel	0	2½
Sand, ½ do.	0	0½
Labour and beer	0	4½
		<hr/>
Cost of ceiling per square yard	1	4½

Cost of ceiling 132 square yards, above and below, 8*l.* 19*s.* 9*d.*

But very excellent ceilings and rough-cast for partitions may be made with clay on a coarse rough sort of lath of small value. The writer of this article brings home from the wood bundles of ash and willow poles about 12 or 15 feet long, too slight for hop-poles. They are tied in bundles for sale, at the usual price of 1*s.* 4*d.* per bundle of twenty-four poles; the thin knotty ends, which will not bear riving, are then cut off, leaving the other end 7 feet long. These latter are split and shaved and packed in bundles of sixty each, at a cost of 1*s.* per bundle: the cost of a bundle of this lath is therefore that of 1½ bundles of poles, increased by the cost of riving and shaving, or 2*s.* 8*d.*: but the remaining knotty ends are worth 6*d.* per bundle, leaving the cost of a bundle of lath at 2*s.* 2*d.*; each bundle suffices for 6 square yards.

	<i>s.</i>	<i>d.</i>
Cost of lath for 1 square yard	0	4½
Cost of nails do.	0	2
Labour and beer do.	0	6
		<hr/>
Cost of 1 square yard	1	0½

Total cost of ceiling 132 square yards with clay £6 17 6

One bunch of rough-cast lath will do 4 yards and costs 2*s.* 8*d.*

	<i>s.</i>	<i>d.</i>
Lath for rough-cast per yard	0	8
Hair 1 lb. do.	0	2
Nails do.	0	3
Lime ¼ bushel do.	0	3½
Sand ¼ bushel do.	0	0½
Labour and beer do.	0	6½
		<hr/>
Cost of rough-cast for 1 yard	2	0½

Cost of plastering 51 square yards of inside partitions with lime mortar, at 2s. 0½d. per yard £5 3 0½

Cost of plastering 51 square yards of inside partitions with clay, at 1s. 0½d. per yard £2 13 1½

Of outside wall there will be about 208 square yards, which must be "rendered" within if built with stone.

	s.	d.
⅔ bushel of lime per yard	0	3½
⅔ bushel of sand do.	0	0½
¼ lb. of hair do.	0	1½
Labour and beer do.	0	3

Cost of rendering per yard 0 8½

Cost of about 208 square yards of stone-work	£.	s.	d.
at 3s. 0½d.	31	12	8
Rendering the same within at 8½d.	7	7	4

Total cost of stone-wall fit for occupation £39 0 0

If the walls are built of clay, 14 inches thick, there will be required—

	£.	s.	d.
14 square yards of stone-pinning at 3s. 0½d.	2	2	7
194 do. clay at 1s. 6d.	14	11	0

Total cost of clay-wall fit for occupation £16 13 7

Windows.

Each of the dwelling-room windows is 10½ square feet.

Each of the other windows is 5 square feet.

There will be required 51 square feet of windows.

	£.	s.	d.
51 square feet of wooden-frame at 8d.	1	14	0
51 do. casements at 8d.	1	14	0
51 do. glazing at 1s. 6d.	3	16	6
	£7	4	6

Total cost of windows with oak-sill and deal-frames 1½ inches, and lintel, hinges, and fastenings complete, except painting £7 4 6

N.B. The window-stiles will be of wood, and the panes so arranged as to have 12 in each window.

For inside partitions the studs should be 4 inches by 2 inches, standing upon a sill 4 inches by 3 inches, and nailed to the floor-joists and tie-beams.

	£.	s.	d.
Framing about $5\frac{1}{2}$ square, at 3s.	0	16	6
Material for do. at 20s.	5	10	0
About 20 running feet of 4-inch pinning	0	6	0
Total cost of stud-work for partitions	£6	12	6

Stairs.

To rise 8 feet, being 2 feet 6 inches broad, made of $\frac{3}{4}$ -inch Memel timber, strings to do. 9 inches by $1\frac{1}{2}$ inch.

	£.	s.	d.
In all, suppose 30 feet at 8d. per foot	1	0	0
Cost of 2 pairs of stairs	£2	0	0
2 doors to closets under the stairs complete, at 9s.	0	18	0
$\frac{1}{2}$ square of stud-work to closets	0	11	6
5 square yards of clay-plastering to do.	0	5	$2\frac{1}{2}$
Total cost of closets	£1	14	$8\frac{1}{2}$

The ceiling-joists for the chambers will be 1 foot apart, 42 of them will be required about 13 feet long each, and $2\frac{1}{2}$ inches by $1\frac{1}{2}$ inches; they will be partly supported from the rafters.

	£.	s.	d.
Materials for 6 squares, at 8s. 6d.	2	11	0
Labour and nails, 6 squares, at 3s.	0	18	0
Total cost of carpenter's work for chamber-ceiling	£3	9	0

Chamber-floor.

Floor-boards $\frac{3}{4}$ inches white deal.

Floor-joists 6 inches by $1\frac{1}{2}$ inch white deal, and 1 foot apart.

	£.	s.	d.
Framing 6 squares of joists at 2s. 6d.	0	15	0
Framing 6 squares of floor at 5s.	1	10	0
Materials	11	11	0
Bond-timber for the joists to rest on	0	15	0
200 feet of tile-skirting	0	9	0
Total cost of chamber-floor	£15	0	0

Doors.

Outside door-jambs $4\frac{1}{2}$ inches by 3 inches.

Outside oak-sill $4\frac{1}{2}$ inches by 4 inches.

Door 1 inch thick, 2 feet 9 inches wide, 5 feet 10 inches high, 1 inch ledges, the door-studs being rabbeted.

Each door complete, painted and hung . . . £1 7 0

Inside doors $\frac{3}{4}$ -inch board, hung on the studs, which are rabbeted, and oak-sill, each door 13s.

	£.	s.	d.
2 outside doors at 11. 7s. each	2	14	0
6 inside doors at 13s.	3	18	0
Total cost of doors	£6	12	0

Thatched Roof.

Larch poles make excellent rafters for a thatched roof, if properly seasoned: they may be purchased as the thinnings of plantations in almost all situations; the smallest of them, and the small ends of the largest, may be chopped into single rafters: others may be sawn into two, while some will make four. The smallest of the ends will work in round the hips of the roof; for I intend it to be what is called cap-ended, that is, having no gables. The cost of larch varies of course, but we shall not put it too low at 1s. for a rafter 11 feet long; I think I should be nearer the mark at 9d. Nails, sawing, framing done for 5s. or 6s. per square of 100 feet. Lath for thatcher, cost 1s. 6d. or 2s. per square; being done with listings (thin slabs) or rough lath. A ton of straw, threshed by flail, costing 40s., will cover more than 3 squares, say 12s. 6d. for 1 square.

Thatcher 4s. 6d. per square and beer, say 5s.

Brotches, nails, and rope-yarn, 2s. 6d.

There will be required for wall-plates and end-beams 130 feet run of stuff 6 inches by $4\frac{1}{2}$ inches; this may be of foreign timber, or any other suitable wood: I put it at 2s. 4d. per cubic foot, which is the price of Memel timber.

The rafters will be 16 inches apart from middle to middle.

	£.	s.	d.
Cost of plates	2	16	0
27 pairs of rafters 11 feet long	2	14	0
4 hip-rafters 14 feet long	0	6	0
250 feet of short rafters for hips	1	2	0
Collar-beams $7\frac{1}{2}$ feet long, and 6 inches by $1\frac{1}{2}$ inch	0	8	6
1 ridge-board 36 feet long, and 5 inches by $1\frac{1}{4}$ inch	0	4	0
2 perlines about 45 feet long each, being larch	0	9	0

	£.	s.	d.
2 tie-beams over the partitions 5 inches by 2½ inches, 15 feet long each		0	7 0
Framing 12½ squares, at 6s.		3	15 0
Straw for about 14 squares of thatchers' measure, at 12s. 6d. }		14	0 0*
And thatcher for labour, broches, &c., at 7s. 6d. . . . }			
130 feet of cants to cut the straw to, at 1½d. per foot . . .		0	16 3
12½ squares of thatchers' lath, at 1s. 6d.		0	18 9
Total cost of thatched roof	£27	16	6

The whole ground-plan of the double cottage here described and the gardens may be about one quarter of an acre. A fence will be required all round, in length about 26 rods. This may be a ditch and bank, or bank only with a live fence of whitethorn. The whole of this may be done at 2s. per rod, finding the whitethorn plants and putting on a dead fence to protect it in the first instance. Two small gates will be required. The whole cost of fencing, gates, and necessary out-buildings may be put at 9l. 11s. 8d., including a trifle for painting windows and sundries.

Total Cost of Cottage with Clay Walls and Thatched Roof.

	£.	s.	d.
Chimneys	4	4	6
Ovens	3	7	6
Paving	5	16	11
Skirting	0	6	0
Clay ceiling	6	17	6
Clay partitions	2	13	1½
Clay wall	16	13	7
Windows	7	4	6
Stud-work of partitions	6	12	6
Stairs	2	0	0
Closets	1	14	8½
Ceiling-joists, &c.	3	9	0
Chamber-floors	15	0	0
Doors	6	12	0
Roof	27	16	6
Out-buildings, &c.	9	11	8

Total cost of two cottages . . £120 0 0

Cost of one cottage . . . £60 0 0

* An advertisement appears in the Bury paper this winter offering to cover buildings with reed and a roving of sedge at 1l. 8s. per square complete.

N.B.—Reed thatching requires no lath.

Cost of Cottage with Stone Walls and Thatched Roof and Lime-Ceilings, &c.

	£.	s.	d.
Chimneys	4	4	6
Ovens	3	7	6
Paving	5	16	11
Skirting	0	6	0
Lime ceilings	8	18	9
Lime partitions	5	3	0½
Stone wall	39	0	0
Windows	7	4	6
Stud partitions	6	12	6
Stairs	2	0	0
Closets	1	14	8½
Ceiling, joists, &c.	3	9	0
Floors	15	0	0
Doors	6	12	0
Roof	27	16	6
Out-buildings, &c.	9	11	8
<hr/>			
Total cost of stone cottage	£146	17	7½

The cost of building cottages containing the same accommodation as those I am describing, with any other material than stone, and clay, and thatch, is so great that no persons will be likely to take them in hand to whom estimates are any object, and on that account I do not furnish them.

It will be observed that in giving my estimates I did not confine myself to the exact dimensions as far as inches; thus the inside width of the cottage is in reality only 12 ft. 8 in. instead of 13 ft. But this is not material. The price of materials and labour will doubtless vary in different districts; but the sum total will not be far different from mine. My calculation is made for the central part of Suffolk. The cottage I have described is of a superior description to those generally inhabited by agricultural labourers, and the rent may fairly be put at 3*l.* 3*s.*

Labourers are sensible of the comfort of good houses, and would be able and willing to pay that sum, and this would yield an interest of 5½ per cent. on the outlay; which, added to the advantage in a social point of view of good dwellings for the poor, should be a sufficient inducement to the gentry to adopt this mode of improving their estates. Gentlemen who have timber of their own may bring it to a good market by cottage-building; for I have allowed 2*s.* 4*d.* per foot for all that I have used. Elm, or poplar, or ash, &c., do as well as foreign timber for floors, stair-cases, ceilings, joists, wall-plates, and stud-work.

One further suggestion I would make before I dismiss this subject: it is the propriety of building independent apartments of

small dimensions for aged women ; so that those who object to the Union House may continue to reside in the neighbourhood of their friends.

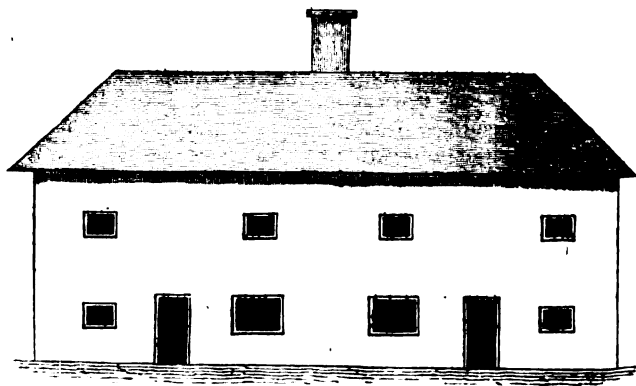
One room, 13 feet square, will be sufficient, in which the bed will stand ; no oven is wanted ; the double chimney in the middle may be small, say 3 feet by 3 feet at the base ; thus leaving a space on each side of it ; 5 feet by 3 feet for a closet, one in each house. The outside measure for two apartments will be 30 feet by 15, and 8 feet high to the eaves. It will be observed that I do not recommend ceiling on the rafters, because the additional cost of lath and plaster almost equals the saving in ceiling-joists ; and the cost of a foot or two more in height of clay-wall is hardly worth thinking of. A flat ceiling, too, has this advantage, that in after years one defective rafter can be removed without disturbing the ceiling ; and thatching-hooks may be dispensed with.

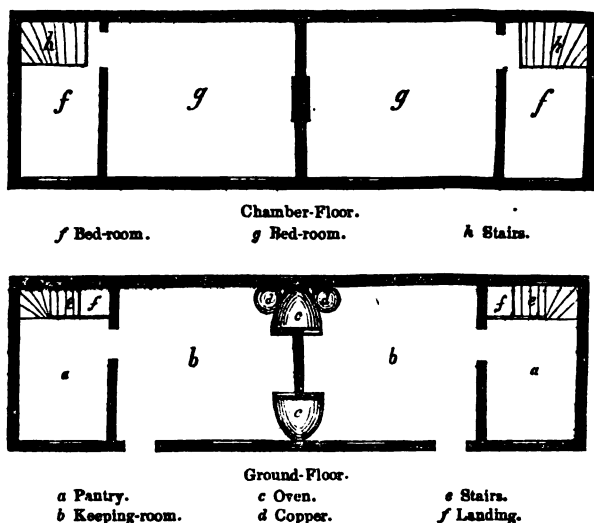
	£.	s.	d.
Chimney	3	0	0
Paving 39 square yards	3	14	9
Skirting	0	4	0
Clay ceiling	2	0	7½
Clay partitions	0	15	7½
Clay walls	6	15	6
Windows	2	16	0
Stud-work of partitions and closet-doors, &c. .	2	14	6
Ceiling-joists	2	6	0
Doors	2	14	0
Roof	18	0	0
Out-buildings	4	19	0

Total cost of two cottages . . . £50 0 0

The rent of each of these apartments may be put at 30s., which would pay 6 per cent.

Scale $\frac{1}{4}$ inch to a foot.





XXVII.—*Report on Drain-Tiles and Drainage.* By JOSIAH PARKES, Consulting Engineer to the Society.

THE Society had offered a premium of ten sovereigns for the drain-tile which should fulfil certain specified conditions; but it was found impossible, in the show-yard, to authenticate the facts required; consequently this prize was not adjudged. A silver medal was awarded by the Judges to each of the following implements, or sets of tiles exhibited: viz., to the Tweeddale Patent Tile and Brick Company, London, for their hand-tile machine, invented by the Marquis of Tweeddale, and shown at work; to Mr. F. W. Etheredge, of the Woodlands, near Southampton, for tiles and covers produced by his new patent machine; to Mr. John Read, 35, Regent Circus, Piccadilly, London, for specimens of cylindric or pipe-tiles invented by him; and to Messrs. Ransome, of Ipswich, for a Beart's brick-machine improved by Mr. A. Stickney, of Ridgemont, Holderness. Since the meeting correct information has been sought for as to the selling price, durability, effectiveness, &c. of the several kinds of tile rewarded; and, at the instance of the Council, the writer has visited Mr. Etheredge's tilery at Eling, near Southampton, as well as one near Penshurst, in Kent, producing the pipe-tiles. The dimensions, weight, and price of these various tiles are arranged and contrasted in the following table:—

Kind of Tile.	Internal Dimen- sions.		Area. Sq. in.	Weight per thousand.		Length In.	Weight per 1000 feet.		Linear feet per ton.	Thick- ness of Material	Price per thousand.			Price per 1000 feet.		
	In.	In.		Lbs.			Lbs.	Ft.			£.	s.	d.	£.	s.	d.
Tweeddale .	2½	by 2½	6.75	5500	tiles and soles.	14½	4631	484	0.55		2	2	0	1	15	4
Etheredge .	2½	— 1½	3.18	5376	" "	14½	4597	495	0.65							
"	2½	— 1½	3.18	5600	" and covers.	14½	4717	475	0.65		1	10	0	1	5	3
"	1½	— 1½	1.56	5152	" "	14½	4338	539	0.65							
"	1½	— 1½	1.56	4928	" and soles.	14½	4150	516	0.65							
Read, No. 1	2.25 diam.		3.97	2844	pipe.	12	2844	787	0.40		1	18	0	1	18	0
"	2	3.00	3.14	2657	"	12	2657	843	0.40		1	14	0	1	14	0
"	3	1.60	2.01	1937	"	12	1937	1156	0.35		1	9	0	1	9	0
"	4	1.35	1.43	1313	"	12	1313	1706	0.35		1	5	0	1	5	0
"	5	1.00	0.79	1032	"	12	1032	2170	0.25		1	1	0	1	1	0

Tweeddale Tile.—The particulars of this tile were obligingly furnished by Mr. Thomas Bennett, of Park Farm, near Woburn, steward to his Grace the Duke of Bedford. The machine is well known, and needs no description. Mr. Bennett states its advantages to consist in economising the labour of making to a small extent; in giving a greater certainty to the quantity made; and in producing a better article than tiles of the same kind manufactured in the ordinary manner. This superior quality arises from the greater density given to the clay in passing through the machine than can be obtained by hand labour. The price quoted is that charged by Mr. Bennett from the kiln to the estate, covering a moderate manufacturer's profit, the cost of the coals used to burn the tiles being 25s. per ton. The machine requires a man and a stout lad to work it, and two boys to carry the tiles to the drying shelves. He considers it to be adequate, in a fair season, to the production of about 600,000 tiles, and as many soles. The present price of the machine is 40*l.* The price at which these tiles can be manufactured and sold to the public is stated by the Company to vary from 23*s.* 6*d.* to 40*s.* per thousand, according to circumstances, size, and the price of coals, to which has to be added one-half more for the soles. This machine requires a pug-mill, and the usual appurtenances of a tiler. About nineteen of them are in use in different parts of the kingdom.

Tile and Cover.—Mr. Etheredge's machine consists in the adaptation of a series of dies of a peculiar form to the bottom of a pug-mill, through which the clay is expressed, and received on mandrils answering to the form of the die. The mill erected at his works at Eling, and substantially made by Messrs. Ransome, contains eight of these dies. It is driven by one horse at a time. The horses have been supplied during the present year by Mr. Webster, of Hounslow, a neighbouring agriculturist, at the rate of 1*s.* per thousand tiles and 6*d.* per thousand covers or soles. He states that by changing the horse every three hours, the work has been satisfactorily performed by two blind but able horses, which

cost him 20*l.* in London. This machine is represented as capable of producing a thousand tiles and as many soles or covers per hour; but it may, perhaps, be advisable to consider its average work in a season at 8000 per day. The hands employed are one man to fill the mill; two boys to cut off the pipes and place them on barrows; one man and a boy to wheel away and set them to dry on frames (provincially termed *hakes*), covered with cloth, supported on iron standards. To fill the kiln, burn, and draw the tiles, two men, a boy, and a burner are required; the kiln holding 36,000. The selling price for the current year of the two sizes most used in the neighbourhood is stated in the Table, as given to the writer by some of the consumers. Coals about 20*s.* per ton. Mr. Etheredge contemplates the being able to reduce this price by fixing fifteen dies in a mill instead of eight, and by economising several items of cost indicated by his experience of this first mill. Much ingenuity has been exercised in the construction of the mill and dies. Two tiles and two soles or covers are comprised in each pipe extruded from the machine, which being nearly severed within in four vertical lines whilst passing through the die, breaks by the shrinkage consequent on drying into four parts. The form, dimensions, and substance of the tile may be varied from the perfect hollow cylinder, to the oval, horse-shoe, angular, or any other desirable figure. The price of the mill with eight dies is 43*l.*, and proportionally less or greater, for smaller or larger machines. The patentee states that the cost of an establishment will vary from 150*l.* to 350*l.*, according to the number of tiles required to be made during a season.

The Rev. Edward Timson, of the Woodlands, near Southampton, who has purchased and used a large number, speaks highly of the efficacy and stability of these tiles and covers, and expresses no doubt of their superiority over the ordinary tile and sole, independently of the difference in price and cost of the drains. Previously to the formation of Mr. Etheredge's works he had paid 50*s.* for the common tiles, and 20*s.* for the soles, per thousand. He observes: "I have drained with stones, alder, and sods, and without any hesitation I give the preference to the mode I am now pursuing. I pay for digging out, laying the tiles, and filling-in the drains, 3*d.* per rod; I before paid for the common tiles 5*d.* per rod." Mr. Timson has used the largest of the two sizes of tile and cover given in the table.

Mr. W. B. Webster, of Hounslow, was draining a piece of very tenacious clay land with the smallest size of tile and cover. These drains were 21 feet apart and 27 inches deep, the digging, laying, and filling-in costing 3*d.* per rod, which seems to be the current price of the country where the ground moves well to that

depth, and is free from gravel. He estimates the entire cost of drainage, on these data, at 5*l.* per acre, that of surveying the land, laying out the drains, &c., inclusive. Many other gentlemen have adopted the same small-sized tile, and unite in one opinion as to the economy and good action of such drains. The concave part of the tile forms the bottom of the drain, which is excavated to the same dimensions by the narrow spade and scoop.

The whole of this year's produce from the tilery had been disposed of, and the writer was informed that Mr. Etheredge had already sold above fifty machines of different sizes.

Pipe-tile.—It does not appear, from the inquiries made on this subject, that pipes have been anywhere used for land-drains at a period more remote than thirty-five years since, about which time Mr. John Read made and employed them when farm-servant to the late Rev. Dr. Marriott, of Horsemonden, in Kent. These original pipes were about 3 inches diameter in the bore, and were formed by bending a sheet of clay, as usually prepared for the common drain-tile, over a wooden cylindric mandril. In consequence of the imperfect union of the two faces of the clay, a narrow slit was left throughout the length of the tile, which served, and was then thought necessary, to admit the water. They were found to act well, but their use did not extend so rapidly as it might otherwise have done had not Mr. Read quitted his farming employment to devote himself, in London, to the manufacture of his celebrated stomach-pump, and other surgical and veterinary instruments. Tiles on this plan have been made during the last three years in the parish of Saylherst, in Sussex, and their efficiency may be judged of by the following statement contained in a letter to Mr. Read from Mr. Henry Putland, of Hurst Green, in the same parish. It is dated the 9th of November, of the present year:—

“The recent heavy rains give me an opportunity of making some observations on the effects of the under-draining I have done with your pipe-tiles, and also of the use of your patent subsoil or mole plough. Last winter I thorough-drained three fields, say Nos. 1, 2, 3. No. 1 was then sown with winter tares; No. 2 afterwards sown with beans; and both pieces gave more than an average crop this first year. It was my intention to have had turnips on No. 3, but from the extreme stiffness of the soil I found it impossible to get a season for them; it therefore remained a clean summer fallow. The three fields are now sown with wheat on ridges (or stetches), and the mole-plough was run through the open furrow between the stetches after the seed was sown, thus leaving the land as near plain as possible. On minute inspection I have found Nos. 1 and 2, after very heavy rains, comparatively dry on the surface, yet with scarcely any water running either from the mole-drains, or from the tiles, which I can easily account for. In consequence of the

dry summer the clay was acted on as well by the air from above, as from the pipe-tile at bottom, which caused the clay to crack, and by that means to carry the water down below the tile. The late rains, however, having in some measure saturated the deep subsoil, the water now runs from the tiles as clear as from a filter. No. 3 is totally different from Nos. 1 and 2. From being constantly worked during the summer the subsoil was prevented from becoming porous, and a considerable run of water has taken place from the mole as well as the tile-drains. The cost of the tiles used is 20s. per thousand, weighing about 1 lb. each, or 8000 making a load of $8\frac{1}{2}$ tons. I have no doubt but the next time the fields in question are sown with corn, water-furrows will be unnecessary."

The preparation of a perfect cylindric tile, as now made by machine, seems to have originated in Essex, whence it travelled into Suffolk and Sussex, in both which counties it has taken root, as shown by Mr. Pusey in his paper "On Thorough-draining" in the last Journal; since the publication of which, and in consequence of the stimulus excited by it, the Kentish farmers have vindicated their appreciation of the system by establishing pipetileries in the following districts:—

1	in the parish of	Penshurst.
1	"	Cranbrook.
1	"	Horsemonden.
2	"	Hadlow.
1	"	East Peckham.
1	"	Yalding.
1	"	Cheddington.
1	"	Bennenden.
1	"	Tunbridge.

It is calculated that from these ten little establishments 1,000,000 feet of tiles have been already produced, of which the greater part is sold; and other tileries are in progress.

The machine is of the simplest construction, its cost being about 6*l.* or 7*l.* It consists of a mere frame of wood, having a cross-bench or platform, upon which is placed an iron cylinder about 17 inches long, by $6\frac{1}{4}$ inches diameter, fitted with the mould or die at its bottom. Its capacity is about 608 cubic inches, which bulk of clay suffices for the production of 24 pipes of the smallest, or No. 5, size. (See Table.) This cylinder, when filled with well-washed and pugged clay, is placed on the platform over a hole, and has an iron-ring on the top fitting the inside, upon which rests a wooden piston or plug attached to a cross-bar, which slides up and down in a groove formed in each upright of the frame. By means of a wooden axle connected by two short cords with the piston cross-bar, and a handspike, the man forces down the piston, and expresses the clay through the die. The

pipe is received by a boy on a stick, loosely fitting its bore, which also gauges the length of each pipe: it is then cut off by a wire, placed on a hand-barrow, and carried to the adjoining drying-shed by another boy. One man and two boys make about 1800 per day of the smallest sized pipe. It is requisite that the clay be well washed and sieved before pugging, for the manufacture of these tiles, or the operation of drawing them would be greatly impeded by having to remove stones from the small space surrounding the die which determines the thickness of the pipe. But, it results from this necessary washing, that the substance of the pipe is uniformly and extremely dense, which consequently gives to it immense strength, and ensures a durability which cannot belong to a more porous though thicker tile. The clay is brought from the pug-mill so dry that, when squeezed through the machine, not a drop of water exudes; moisture is, indeed, scarcely apparent on the surface of the raw pipe. Hence, the tiles undergo little or no change of figure whilst drying, which takes place very rapidly by reason of their form and slight substance. They are placed in the kiln when containing only about 12 per cent. of moisture, in consequence of which there is but trifling loss in the burning, which was effected at the Penshurst works with brushwood; but the selling price is the same at other works where coals are used at about 20s. per ton. A pipe shrinks about 15 per cent. in its length between its raw state from the press and when burnt. These particulars refer to the clay at Penshurst; they will vary a little with the nature of the clay used.

It is estimated that a manufactory of these pipe-tiles may be added to any existing brick-field, at an expense of about 100*l.*, and for a less sum where kilns and pug-mills are in use. This estimate includes the machine with a single die, a pug-mill, washing apparatus, kiln, and drying-shed. The manufacture might be carried on throughout the winter by securing the raw pipes against frost. This would necessarily occasion some additional outlay, but it is thought would not enhance the cost of the tiles, as the hands would not lie idle. It is a consequence arising from the small dimensions and weight, together with the comparative dryness of the tile when produced, which properties diminish to a *minimum* the bulk of the material used, and the space required for manufacturing and drying. Such an establishment would suffice for the annual production of 540,000 tiles, which is equivalent to the annual drainage of about 240 acres of land, from 30 to 36 inches in depth, at a mean of about 20 feet between the drains, and at a cost not exceeding 3*l.* per acre in clays and firm-bottomed soils, unencumbered with stones.

Other important advantages attend the cylindric figure and light weight of the pipe-tiles, viz. the diminished cost of carriage,

and the faculty of conveying them into the field by hand. Two men can carry on a hand-barrow 240 to 300 of the pipes used for the parallel drains, making 80 to 100 yards. Mr. Hammond has drawn 10,100 of these tiles, in one waggon, from the tilery to his farm, distant about 3 miles. Such a load of them is not recommended for long journeys, and is only cited as illustrative of a valuable property which will be appreciated by agriculturists; and it shows that these tiles are peculiarly suitable for stowage and transport. The breakage, with ordinary care, is very inconsiderable. The weights of all the tiles cited in the table are those when fresh out of the kiln, *i.e.* absolutely dry. The writer has found that the pipe-tile, when thoroughly saturated with water, weighs about one-seventh heavier.

The following information was collected in Kent as to the practice, efficiency, and cost of draining with these tiles:—Mr. Thomas Hammond, of Penshurst (see his letter to Mr. Pusey, *Journal*, vol. iv. p. 47), now uses no other size for the parallel drains than the inch tile in the table (No. 5), having commenced with No. 4; and it may be here stated that the opinion of all the farmers who have used them in the Weald, is, that a bore of an inch area is abundantly large. A piece of 9 acres, now sown with wheat, was observed by the writer thirty-six hours after the termination of a rain which fell heavily and incessantly during twelve hours on the 7th of November. This field was drained in March, 1842, to the depth of 30 to 36 inches, at a distance of 24 feet asunder, the length of each drain being 235 yards. Each drain emptied itself through a fence bank into a running stream in a road below it: the discharge, therefore, was distinctly observable. Two or three of the pipes had now ceased running; and, with the exception of one which tapped a small spring, and gave a stream about the size of a tobacco-pipe, the run from the others did not exceed the size of a wheat-straw. The greatest flow had been observed by Mr. Hammond at no time to exceed the half-bore of the pipes. The fall in this field is very great, and the drains are laid in the direction of the fall, which has always been the practice in this district. The issuing water was transparently clear; and Mr. Hammond states that he has never observed cloudiness, except for a short time after very heavy flushes of rain, when the drains are quickly cleared of all sediment, in consequence of the velocity and force of the water passing through so small a channel. Infiltration through the soil and into the pipes must in this case be considered to have been perfect; and their observed action is the more determinate and valuable, as regards time and effect, as the land was saturated with moisture previously to this particular fall of rain, and the

pipes had ceased to run when it commenced. This piece had, previously to its drainage, necessarily been cultivated in narrow stetches, with an open water-furrow between them; but it was now laid quite plain, by which one-eighth of the acreage has been saved. Not, however, being confident as to the soil having already become so porous as to dispense entirely with surface-drains, Mr. Hammond had drawn two long water-furrows diagonally across the field. On examining these, it appeared that very little water had flowed along any part of them during these twelve hours of rain; no water had escaped at their outfall; the entire of the rain had permeated the mass of the bed, and passed off through the inch pipes; no water was perceptible on the surface, which used to carry it throughout. The subsoil is a brick clay, but it appears to crack very rapidly by the shrinkage consequent to draining.

A hop-ground, having a similar subsoil, was next examined, in which the drains were laid 25 feet asunder, and from 3 to 4 feet in depth, the length of each inch-pipe drain being 150 yards. The effects were here even greater than the foregoing, every pipe having ceased to run; and, on digging, the ground broke up in a highly porous, dry, pulverulent state. As hop-grounds are annually forked about 8 inches in depth, this may account for the somewhat freer descent and more rapid escape of the water.

A turnip piece was drained in March of the present year, 24 to 30 inches deep, ploughed and subsoiled 14 inches deep. The crop of swedes and turnips was a fair average, though the seed could not be got in till the last week in June. It was in an excellent state as regards dryness. The active soil of this piece was about 10 to 12 inches deep, and all below a very tenacious yellow clay. Mr. Hammond states that the turnip could not have succeeded on this land unless it had been so treated.

The result of this gentleman's experience is, that the cost of drainage with the pipe-tiles, at a medium depth and width asunder, is about 3*l.* per acre, and that he is repaid by the first year's crop. The cost of cutting such drains, laying the tiles, and filling-in, in these clays, is 3*d.* per rod. The work is capitally executed by the Kentish labourers; and when a line of open drain, with the pipe-tile at the bottom, is looked at, every preconceived doubt vanishes as to the durable character and filtrating power of these small pipe-drains. It has been frequently asked, "How is the water to get into these pipes?" The more pertinent question would be, "How is the water to be kept out of them?" Mr. Hammond attempted to convey a spring of good water to his house by setting these pipe-tiles in mortar, and ramming them up with clay; but he did not succeed in keeping

the water within the pipes. He was obliged to cut off the spring, and afterwards found this line of pipe, though so laid, effectually to drain the land through which it passed.

Mr. Henry Simmonds, of Hadlow, whose farm was next visited, has practised under-draining extensively with sods, stone, wood, and the common tile, but prefers the pipe-tile under every point of view. He was found draining a large piece at 3 rods between the drains, and at 36 to 42 inches in depth; his object being to withdraw water stagnating in a subsoil of gravel at this depth, as well as to dry the upper active soil. The length of these drains is 165 yards, and the fall about 18 inches, or about 1 in 330. Being unable to procure a sufficiency of the inch pipes, he used these at the upper end of the field, and No. 4 at the lower end. These parallel drains emptied themselves into a cross-drain formed of the No. 1 tile. The digging cost 8*d.* per rod, in consequence of the pickaxe being necessary in the gravel; but the total cost per acre would not exceed 5*l.*, though enhanced by the necessity of pushing the main-drain 500 yards in length, in order to reach the outfall.

These pipes have been used by Mr. Simmonds with equal success in falls much less than the foregoing; and no doubt seems to exist in the mind of any party, who has had experience of them, as to their keeping open where any other kind of tile-drain would draw. He has thorough-drained with pipes several pieces originally done too shallow, which has laid them completely dry, the pipe-drains absorbing the whole of the water. As occasion may require, he lays two of the No. 1 pipes side by side for main-drains, preferring them much to the old tile and sole, and they make a capital job.

Mr. Kepping, of Hadlow, was draining a hop-ground 4 feet deep with the No. 4 pipe at 4 rods, or 66 feet asunder; the bottom varying in parts between gravel, clay, and a sandy loam: and another piece, at 3 rods apart, at the same depth. The first of these would cost—

	£	s.	d.
660 feet of pipes per acre, at 21 <i>s.</i> per thousand	0	13	8
40 rods of digging at 8 <i>d.</i> per rod	.	1	6 8
Total	£2	0	4

The second would cost—

	£	s.	d.
880 feet of pipes per acre, at 21 <i>s.</i> per thousand	0	18	5
53½ rods of digging, at 8 <i>d.</i> per rod	.	1	15 8
Total	£2	14	1

The price of the pipes cited is that of No. 5 in the table, as Mr. Kepping would have used them of that size instead of No. 4, could he have procured them.

Mr. Golding, of Peckham, has also done much draining in a similar manner, as well as many other agriculturists in the Weald of Kent.

Mr. John Taylor, of Brewer's Hall, Mereworth, Kent, makes and authorizes the following statement:—

“ I first commenced using the round tiles on a farm called Tatlingbury, in the parishes of Capel and Tudely, in 1840. They were 12 inches long, $1\frac{1}{2}$ inch bore, cost 48s., and weighed about 25 cwt. per thousand. These were the original kind of pipes. In every instance they gave me perfect satisfaction. There is now another sort of pipe-tiles made by machine, having no opening in their length, only at the joints, and much thinner, which are used to greater advantage. They are to be bought at 22s. per thousand, and are nearly two-thirds lighter, which, with the carriage, makes the cost of drainage less by quite 40s. per acre, at 80 rods of drain per acre: I have used them in drains over 40 rods long, and never saw one pipe more than two-thirds full of water. Within half an hour after heavy rain commences these drains run fast, and in a few hours after its cessation they run but slowly, consequently a large and expensive tile is useless where a much smaller and cheaper one will do the same work. I have my drains dug from 3 feet 6 inches to 4 feet deep; the bottom of the drain is left for the pipe to quite fill it, so that it is impossible for the pipe to move after it is put into the drain. Clay is then well rammed over the pipes to 2 feet in depth, which I prefer to anything else when it can be got to cover the tile. Digging costs me in my clay land from 6d. to 9d. per rod, at 3 feet 6 inches to 4 feet deep, as in some of it there is a subsoil of black gravel which requires the pick-mattock; and under the gravel are land-springs. I have also used these pipes on boggy soils which would produce neither grass nor corn; they now give good crops of both. These drains run throughout the whole summer. I have thoroughly drained 40 acres, and have many other fields partly drained. I should be glad to drain the whole farm, which contains about 300 acres, provided my landlady would find tiles; or I would gladly pay 5 per cent. upon the outlay; but, I am sorry to say, she discontinues to support that first step of improvement, *land-draining*. ”

The principle that less frequent but very deep drains are equally effective with more numerous and shallower ones, is recognised by these intelligent and practical farmers; but in respect of number, as well as depth of drains, it is evident that no precise rule can be laid down, as so much depends upon the procuring an outfall, upon the character of the soil, &c. It must also be considered as a discovery of no slight national importance that experience has proved a very much smaller area of drain to suffice for passing the water filtrating through an acre of land than has hitherto been imagined; for it is mainly owing to the substantia-

tion of this fact that the pipe-tile of the eastern counties, and Mr. Etheredge's small tiles and covers, can be applied with such a remarkable economy in comparison with the old tile, and with most other materials hitherto employed in drainage. An advantage incidental to the use of tiles and pipes of small bore is, that neither the mole nor the rabbit—those pests of the farmer—can enter them. The chief enemies to guard against are the roots of trees, particularly those loving moisture. Mr. Hammond has observed the roots of the water-willow to penetrate a rod in length up drains; outfalls, therefore, should be so managed that no fence, trees, or shrubs can mar the working of the drain.

Durability.—Time is the only criterion for forming a perfect estimate of the durability of such an article as the drain-tile; but density and toughness are acknowledged tests of good pottery; and it can scarcely be questioned that the densest tile will endure the longest in the ground. After a careful investigation of the solid contents and weights of the tiles registered in the Table, the following facts appear as regards their density:—

	Weight. Oz.	
Tweeddale .	0·973	per cubic inch of matter.
Etheredge .	1·091	”
Read, No. 1 .	1·138	”
” 2 .	1·174	”
” 3 .	1·204	”
” 4 .	1·322	”
” 5 .	1·401	”

These results seem to be in strict conformity with the degree of preparation of the earth, as well as with the nature and amount of the force to which the respective tiles are subjected in the apparatus employed; and it is seen that the density of the cylindric tile increases in the inverse ratio of the magnitude of the orifice through which the clay is expressed from the cylinder. It must, however, be borne in mind that, in order to render comparisons of this kind free from error, the clay of differently made tiles should be alike; whereas in the foregoing examples the articles were manufactured in separate counties, and from earth of different quality.

XXVIII.—*On the Cultivation of Orchards, and the Making of Cider and Perry.* By FREDERICK FALKNER.

THE advantage of an orchard upon a farm of sufficient size for the supply of cider for the labourers, and the use of the farmer's family, is so generally appreciated in certain districts of the counties of Hereford, Worcester, Gloucester, Somerset, and Devon, as to be thought an almost indispensable appendage, and the absence of it a great objection. Through the larger part of these counties, no other liquor, for ordinary use, is thought of; and it would be considered very expensive and troublesome to be under the necessity of supplying its place by brewing malt liquor. An orchard is besides a source of considerable gain, in affording both common and superior cider for sale, which frequently, under good management, affords a considerable profit. In the expressive language of the farmer, it yields a harvest without a seed-time; and those who have once experienced the benefit and pleasure of its wholesome and luscious supplies, would be sorely annoyed and perplexed by maltsters' bills, and the mysteries of mashing and fermenting, which after all, offer, in their opinion, a very indifferent substitute. An orchard, besides, affords an agreeable variety in the farmer's hopes and pursuits, and no inconsiderable addition to his domestic comforts and enjoyments. It is, indeed, the Englishman's proper and natural vineyard, producing him, almost without labour, fruit of rich and various flavour, more beautiful than the grape, and yielding an abundant supply of a scarcely less agreeable and cheering beverage.

There are three principal circumstances which appear to influence the growth of apple-trees, and to determine their natural localities: namely, climate, soil, and aspect. Though this tree will endure a winter of greater severity than is generally experienced in any part of the British Islands, yet, to bring its fruit to maturity requires a warm summer, and therefore the southern and western counties are more favourable to orchards than those of the north and east, and accordingly they are more generally cultivated in the former than in the latter, even where the soils are of a similar character. If we look at the geological position of the districts above named, where orchards most prevail, we shall find that they are situated upon strata which abound with marls, marly clays, and calcareous sandstone: viz., the marls of the old red sandstone of Herefordshire; those of the new red sandstone; the marly clays of the lias; and the calcareous and often marly beds of the inferior oolite in the counties of Worcester, Gloucester, Somerset, and Devon. The two last strata, however, scarcely extend to Devon. Those who have not visited the cider countries in the spring, particularly the valleys of Somerset and

Devon, can form but a faint conception of the effect of the heaven-showered orchards, blended as it is with all else that excites our admiration of the prodigal bounty and beauty of nature. Witness the valley of the Dart, with very many others. The general prevalence of orchards in these districts, and their greater productiveness than in others, sufficiently indicate that the apple-tree requires a soil more or less calcareous; and from the best fruit being produced by orchards situated upon the red marls of Hereford and the other counties, we may likewise infer that a considerable portion of clay is necessary to the perfection of its produce. Great light has been lately thrown upon the adaptation of soils to particular plants; and it is now easy to account for the predilection, so to speak, of the apple-tree for soils that abound in clays and marls. All deciduous trees require a considerable portion of potash for the elaboration of their juices in the leaves, and are prosperous or otherwise in proportion to the plentiful or scanty supply of that substance in the soil. Liebig has shown that the acids generated in plants are always in union with alkaline or earthy bases, and cannot be produced without their presence.* The most striking exemplification of this necessity is the vine, the leaves, tendrils, and unripe fruit of which are remarkable for their acidity. It has been proved that vineyards supplied with manure of a very forcing kind, but which contains no potash (hornshavings, for instance), soon cease to be productive. Now the apple-tree, during its development, produces a great quantity of acid; and therefore, in a corresponding degree, requires alkaline, and probably earthy bases also, as an indispensable condition to the existence of the fruit. Without such substances therefore in the soil, in adequate abundance, orchards cannot prosper; and it is morally certain that more accurate inquiry and observation will establish the fact, that, all other things being equal, they are productive or otherwise in proportion to the quantity, up to a certain limit, of these substances in the soil. It is known that all clays contain potash, and that marls consist of clay and carbonate of lime, and also contain potash, besides sulphate and phosphate of lime. The presence of alkaline and earthy bases, particularly potash and lime, affords a satisfactory solution of the adaptation of marly soils to the production of apples, even without taking into account the part which phosphate and sulphate of lime play in their formation. These considerations are very interesting, as they are calculated to throw a valuable light upon an important branch of horticulture and rural economy, by pointing out the means of exercising an effectual influence upon soils in the production of apples which are not naturally adapted to that pur-

* *Chemistry of Agriculture and Physiology*, p. 92.

pose. Nor is the opinion above entertained merely speculative, for we have almost everywhere sufficient proof that soils not naturally adapted to the growth of apples are, by the application of manure, made to produce them in great plenty and perfection. It cannot be denied that the ammonia, and also the humus of the decaying dung, must have some influence on the growth of the tree in such soils, and also on the development of the fruit;* but it is at the same time most certain that these alone would be perfectly inefficient for the production of the fruit without the co-operation of those bases which the manure also supplies, and which are naturally deficient in such soils as we are now speaking of. The size, and perhaps the flavour, of the fruit may be somewhat affected by the organic part of the manure, but its very existence depends upon the presence in the soil of a sufficient quantity of those inorganic or mineral substances which are indispensable to the formation of the acids. If further proof be wanting of the effect of potash upon the productiveness of fruit-bearing trees, it is to be found in the benefit derived from manuring apple-trees with leaves which contain it in considerable quantity. This effect is remarkably exemplified in the application of the cuttings of vines to their roots, by which practice vineyards are kept in full bearing for any number of years, without any other manure, and of which Professor Liebig, in his admirable work on agricultural chemistry, has cited two remarkable instances. With these views, it is reasonable to refer the more general cultivation and prevalence of orchards in the districts above named than in any other, principally to the greater abundance of that mineral food so essential to fruit-bearing trees, producing a large quantity of acid. We shall have occasion to revert to this subject in treating of the manuring of orchards.

With regard to aspect, the districts above mentioned as being favourable to orchards have more or less an undulating surface (and therefore present numerous localities whose sheltered and at the same time sunny aspects are favourable both to the setting and ripening of the fruit), and often acclivities, which, though of excellent soil, are too steep either for cultivation or the pasture of heavy cattle. Very open or elevated and exposed situations, and the bottoms of deep-sunk valleys, are almost equally unfavourable: the first from the violence of winds and low temperature, and the latter from their liability to cold fogs and late frosts while the trees are in blossom, which often, in one fatal night, utterly destroy the hopes of the husbandman. In planting an orchard, therefore, the site should not be chosen "in lowly vale

* It is not probable that trees with large systems of leaves can be much indebted to the soil for those organic substances which the atmosphere so abundantly supplies.

fast by a river's side," nor, on the contrary, at an elevation too much exposed, but on moderately sheltered southern slopes, and, when choice will further permit, inclining rather to the east than to the west; for although a slope inclined to the south-west is warmer than one to the south-east, it generally retains the fogs longer, and therefore is more dangerous to the fruit in the spring of the year. A situation much surrounded, or closely hemmed in by woods or plantations, is almost equally objectionable as a close watery bottom, as woods exhale a vast quantity of moisture from their leaves, and the fogs produced over them dissipate much more slowly than those over open ground.

Raising Plants.

Apple-trees are generally purchased from nurserymen, or persons who make a particular business of raising them, and who sell them at prices varying from 2s. to 5s., according to size and quality. They may, however, be raised with great facility by any intelligent farmer; and where orchards are much cultivated, considerable profit might be made by selling them to others. At all events, a few young trees should be always coming forward in the provident farmer's garden, for the purpose of filling up vacancies occasioned by accident or decay. It is a prevailing opinion that the hardiest and best stocks are those which are raised from the seeds of the wild apple or crab; and Mr. Knight recommends that the pips should be taken from the fruit before it is pressed, but the pommey (that is, the pulp after it has been pressed) will generally contain a great number of entire seeds. This pommey, or that from the apples of healthy and vigorous trees, should be thickly laid and covered up in shallow trenches, about 18 inches apart, so as to admit of the young plants being well hoed and hand-weeded in the following summer. Immediately after the fall of the leaf in the ensuing autumn, the strongest plants might be drawn, and planted 18 inches apart in rows of the same distance from each other. The land should have been previously trenched, manured, and cultivated for garden produce. The remainder should be similarly managed in the following year. During their future growth, the ground should be kept perfectly clean by repeated hoeings; and the plants would be much benefited by a light forking between the rows. No knife should be allowed to approach them in this stage, unless it be to shorten a rampant-growing shoot, which may be making too strong a diversion from the stem, and not even then if it be more than a foot from the ground, at least when it is intended to graft the stem; for every twig and leaf contributes to the growth of the root and the stem, the only thing at present to be regarded. When the plants are more than half an inch in diameter, at a foot

from the ground, or about two or three years' old, the head should be removed, and the stock grafted about 10 inches from the surface; and at the same time every sprig and bud of the stock should be carefully taken off, in order that the sap may be more vigorously determined towards the graft. The mode of grafting will be noted presently.

When the graft has grown about 2 feet in height, the plants should be removed or planted out in land similarly prepared, in rows 4 feet asunder, with an equal interval between each plant, where they are to remain until finally removed to the orchard. Before the plants are removed from the grafting-site, no side-shoots should be cut off, except those *below* the graft. On their removal to open rows, any overgrown branch may be shortened, and two or three of the lowest removed close to the stem. After this the *stronger* side-shoots only should be moderately shortened, in order to encourage the upward growth until a good head is formed about 6 or 7 feet from the ground. The side-shoots may then be removed close to the stem in two successive years, while the head is left to its unrestricted growth. It is a very common and bad practice to cut off *all* the side-shoots early, leaving only two or three twigs at the top, by which means the plant is very much checked in its growth, and instead of producing a firm and tapering stem, it becomes almost cylindrical, and tortuous instead of upright. Those who treat plants in this way are undoubtedly ignorant of the true nature of their growth, and the important office of leaves; and, therefore, in attempting to assist Nature in promoting the growth of the head, most injuriously interfere with her operations. If such persons had equal facility of witnessing the growth of the roots, they would no doubt think it their duty to cut part of them away, with a view of promoting the growth of the stem—at least such a proceeding would be not less absurd. Every leaf is a feeder of the plant, no less than every rootlet; and no interference with the progress of the plant should be allowed, except for the purpose of preventing any side-branch becoming a rival to the head. When, however, the plant has attained the required height of stem, and the head has pushed forward strong shoots above that height, the whole of those on the stem may be finally cut away as before directed, the stem having by this time gained sufficient substance and strength to preserve its erect position, and to support the head.

Apple-trees are generally fit for planting out in the orchard at about seven years of age, at which time, if they have been well treated in the nursery, they will be about an inch and a half in diameter at the middle of the stem. The particular age, however, at which trees should be removed to their final destination, after they have formed a good head, is not very important, provided

they do not very much exceed the above size; and the objection to a greater size is the difficulty of taking them up with a due proportion of roots, so as to prevent them receiving too great a check. It must be obvious from analogy that early transplanting is preferable to late, provided the trees be well and substantially fenced against injury from live stock of every kind—that is, with posts and rails, and with thorns immediately surrounding the body of the tree. The habit of keeping the trees in the nursery until they are what are called strong trees, can have arisen only from the feeble fencing they too generally receive, by which the tree is often made the chief support of the protecting thorns or furze.

The subject of grafting necessarily involves that of the selection of sorts. The best fruit, whether for cider-press or the table, are frequently not the most productive. Every individual seed produces a new variety, differing more or less from the parent tree; and all the best varieties we possess are derived from one common parent (the native crab), and owe their excellence to selection and cultivation, in like manner as the most polished society of the present day is derived from a race originally rude and savage.

Each particular variety of apple has its period of vigour and decline, and its duration cannot be protracted by grafting beyond a certain limit; and it is very remarkable that within that natural limit, the grafts partake both of the vigour and the decrepitude of the parent tree or variety. The period of duration is not known with any precision, and perhaps is longer in some varieties than in others. It is generally supposed, however, that it never much exceeds two centuries. Mr. Knight, one of the most profound physiologists of this or any other country, has observed that the disease called canker is always the consequence of grafting trees from very old sorts, and which are in their declining age; and that though the graft will often grow vigorously at first, it soon begins to exhibit symptoms of disease, which no management can avert. •It seems probable that even the power of growing at all cannot be extended beyond the limit, barring accidents, which nature has assigned to the existence of the original parent or patriarch of the family.

Many kinds once very celebrated have long since disappeared from the catalogues of gardeners, and can now nowhere be found; while many other varieties, which were much esteemed in their palmy days of bearing, are fast approaching to extinction, and at the present time present only a few scattered and dwindling specimens, amongst which we regret to number the celebrated Cockagee cider-apple and some excellent pippins. By the industry of horticulturists, however, a great number of new varieties of excellent quality have been raised to supply the place of those we have lost and are losing, in which there is more merit than

would at first thought be supposed ; for a good sort out of the number of seedlings raised is like a prize in a lottery, and it must be remembered that some years must elapse before the experimenter can draw his prize, if indeed there be one for him. Mr. Knight has been one of the greatest experimenters in this way, and has raised many good varieties.

In the purchase of young trees or in grafting, in order to form a productive and profitable orchard, care must be taken to select good sorts, which are either new, or in the vigour of their bearing, whether for the cider-mill, the table, or the kitchen. Apples for these several purposes recommend themselves to our choice by very different qualities, though some few are almost equally well adapted to all purposes. In those for the table we require sweetness, with a subdued and pleasant acidity, and a delicate aromatic flavour. In the kitchen-apple, size, the quality of keeping, and considerable acidity are the principal requisites: acidity is indispensable in apples intended for boiling and making sauce. The best fruit for cider are those which yield the heaviest juice; and these are not, generally speaking, agreeable to the palate. The celebrated Cockagee apple is absolutely uneatable, though it is very fragrant, and inviting to the eye. I was once told by a farmer that he offered a boy a shilling if he would eat one in his presence. The attempt was made, but was soon abandoned, from the impossibility of getting it down. The red and yellow colour of the rind is considered by the farmers in the apple districts as good indications of cider fruit, and apples of the various degrees of those colours are decidedly preferred to those of which the rind is green.

The specific gravity, as the brewers call the weight of their worts, would be the best guide when it can be accurately ascertained. The more obvious qualities by which good cider fruit is distinguished, according to the experience of cider-makers, as stated above, are strikingly exemplified in a table of cider-apples given by Loudon in his valuable 'Cyclopædia of Gardening,' which is here quoted:—

- " Siberian Pippin . . Yellow; firm and juicy.
- Grange Pippin . . Yellow and red; firm, juicy, acid.
- " " Orange and red; firm and juicy.
- Siberian Harvey . . Bright red and green; firm and austere.
- Alban Red and green; firm and very harsh.
- Hogshead Deep red; firm and austere.
- Stead's Kernel . . Yellow and russet; firm and austere.
- Large Styre . . . Yellow and red; firm and sharp.
- Brienton Seedling . Yellow and red; firm and juicy.
- Brierly's Seedling . Yellow; firm and austere.
- Hagloe Crab . . . Yellow; firm and tart.
- Woodcock Dark red and yellow; firm and austere.
- Yellow Siberian . . Very yellow; firm and austere."

These are most of them new kinds, and are described by Knight and Forsyth as good bearers. It will be seen that they are almost all either red, yellow, or a mixture of both; and are described, for the most part, as being either tart, acid, harsh, or austere.

Some diversity of opinion exists in different districts as to the fruit best adapted to making good cider, but this may be chiefly owing to diversity of tastes, some preferring a somewhat austere and dry cider, and others a liquor in which sweetness predominates over the natural acidity of the fruit.

An old writer speaks in the highest terms of a cider made from a mixture of an uneatable pear which grew in the neighbourhood of Ross, in Herefordshire, called the Jenny Winter, and the wild crab. He says,—

“The pear is of no use, except for making cider. If a thief steal it he would incur a speedy vengeance, it being a furious purger; but, being joined with well chosen crabs, and reserved to due maturity, it becomes richer than a good French wine; but if drank before the time it stupifies the roof of the mouth, assaults the brain, and purges more violently than a Galenest. According as it is managed, it proves stronger than Rhenish, Barsac, yea, pleasant Canary, sugar 1 of itself; or as rough as the fiercest Greek wine, holding one, two, three, or more years, so that no mortal can say at what age it proves the best. This we can say, that we have kept it until it burns as quickly as sack, draws the flame like naphtha, and fires the stomach like aqua-vitæ. I made trial at my own house with wine d’Hay, by a merchant at Bristol highly extolled, which, compared with a liquor made of pears and wild crabs, was so much inferior, in the judgment of all, that the comparison was quite ridiculous. A great planter had then by him many tuns of the liquor made of this mixture of fruit, that carried the applause from all palates; and his common yields him store of this fruit. He says that the best of these pears grow on very bare and sandy hills or vales; crabs on any mound or bank that may be raised on a heath; that one pear-tree bears ordinarily 40 or 70 gallons, statute measure, and some seven times as much. Since I undertook this argument, we have made in one year 50,000 hogsheads, and this shows the hardness of the fruit. Let our noble patriots weigh this, the art of raising store of rich wines on our common arable, on our hill and waste grounds: the charge a trifle, the pains small, the profit incredible. For some uses the shadow of the orchard brings on the grass a fortnight the sooner, as commonly for ewes and lambs.”

This is a very high-flown panegyric, and is evidently that of a zealous advocate for the cultivation of orchards; and if the good gentleman wrote under the genial influence of his favourite beverage, which would appear not very unlikely, yet it is fair to adhere to the old adage, *In vino veritas*, notwithstanding some little extravagance of expression. He does not inform us, however, by what difference of management such very opposite qualities as those mentioned are produced, at least with any degree

of satisfactory precision. There can be no question that the quality of cider very much depends upon the kind of fruit employed, and the quality of the same fruit is much influenced both by the soil and the aspect of the orchard.

Knight observes that those apples only which are of a yellow colour, or a mixture of yellow and red, are proper for making the finest kind of cider; but the quality of all cider is very much influenced by the different processes practised in its manufacture, which will be treated of in due course. It would be quite incompatible with the necessary brevity of a treatise of this kind to notice half the apples that are cultivated and recommended, as such notice, even in a tabular form, would occupy a volume. We shall therefore only give a short list of some excellent kinds which are still in vigorous growth, and which are recommended by Mr. Knight as amongst the very best of our cider fruit; and also a list of a few of the best specimens of table and kitchen fruit recommended by Forsyth:—

Cider Apples.

Grange Apple . .	Yellow; a prize apple, raised by Mr. Knight.
Orange Pippin . .	Red and yellow; an excellent and beautiful fruit.
Downton Pippin . .	Yellow; a very fine bearer, and also of first quality for the table.
Foxley Apple . .	Red and yellow; a prize apple; small; numerous.
Best Bache . . .	
Yellow Elliot . .	Yellow, with a red tint; juice astringent; of excellent quality for the press.
Bennete Apple . .	
Golden Harvey . .	Red and patchy; very valuable both for the press and the table; juice very heavy.
Siberian Harvey . .	Red and yellow streaked; very sweet; excellent for the press; juice very heavy (1095).
Stead's Kernel . .	Yellow; a fine fruit both for the press and table.
Garter Apple . .	Red streaked; large and handsome.
Cowarne Red Apple .	Red; large, and much cultivated.

*Table and Kitchen Apples, described and recommended
by Forsyth.*

Jenneting . . .	Yellow; small, early; July.
Codling . . .	Baking; idem; idem.
Margaret Apple . .	Delicate; sweet; August.
Kentish Fill-basket .	Baking; large; August.
Soan's Pearmain . .	Red; fine fruit; September.
Golden Rennet . .	Good table fruit; Michaelmas.
Aromatic Pippin . .	Bright russet; aromatic flavour.
Winter Pearmain . .	Juicy; store well; December.
Kentish Pippin . .	Kitchen apple; good keeper.
Monstrous Rennet . .	Red and green; large.

Royal Russet . . .	Best kitchen and good table fruit; great bearer, and keeps well.
Wheeler's Russet . .	Good kitchen fruit; keeps well.
Nonpareil . . .	Excellent eating apple; not ripe till Christmas.
Golden Pippin . .	Very yellow; old.
Ribston Pippin . .	Slightly streaked with red; excellent both for the table and kitchen.
Pomroy . . .	Larger than the Jenneting; ripens early.
Margill . . .	An excellent apple, and good keeper.
Pearson's Pippin . .	Yellow; flat; very good; baked for sweetmeats.
Fearn's Pippin . .	Beautiful scarlet; good keeper.
Queen's Apple . .	Red and yellow; beautiful and excellent fruit.

In order to ensure the obtaining the most desirable sorts by means of grafts, the orchard from which they are intended to be taken should be carefully inspected in the previous autumn, just as the fruit is arriving at perfection, and the proper trees marked. The grafts, which should be taken off in February, should be of the last year's shoot, and taken from the strong lateral branches of free and vigorous growth. The ends may be cut off, and the part reserved should be about 8 or 10 inches long. They should be kept covered up in dry earth until the middle of March, which is generally the best time for grafting, as the sap then begins to rise freely, and affords a better chance of a successful operation. The immediate object of this operation is to bring the bark and young wood, both of the stock and scion, into close and permanent contact, by which means the vessels of the one are enabled to communicate with those of the other. This is effected by several different methods, which have their various denominations; but that which appears to be most generally approved, in grafting young apple stocks, is what is called saddle-grafting, as affording the best means of bringing into contact a larger surface both of the bark and wood, and thereby giving a better chance of success, and also of preserving the graft firmly in its place. Grafting upon old stocks and large trees is performed by the method called cleft-grafting. These operations, however, require great nicety, and are generally performed by professional gardeners; and as they can be learned by inspection and practice only, it is needless to describe them here. The principle is the same in all cases, namely, to bring a clean recent oblique cut of the corresponding parts together, as mentioned above. They are then firmly fixed by a ligature of bass or garden matting, and preserved from the air by a thick covering of a compound of clay, horse-dung, and chopped hay, previously well blended together.

If the trees are to be purchased from a nursery, ready grafted, and the sorts cannot be relied upon, they should be inspected in the previous summer while in leaf; and those selected which give

the greatest promise of making good and healthy trees, and the most likely to be good bearers. They should have full and flourishing heads, and broad roundish leaves, as such generally bear the largest fruit, and the most abundant crop. In winter such trees will present a larger and fuller bud than those whose leaves are small and pointed; but though these are favourable indications of the size of the fruit, and the productiveness of the tree, they are by no means so with regard to other qualities, as the trees may be early or late bearers, and the fruit red, yellow, or green; and whether they will produce either good cider-apples, or those better adapted to the table, can only be known when they produce their first fruit. If they then prove not such as are desired, or there is too great a proportion of one sort, grafting in the head should be had recourse to. This will, it is true, protract the time of bearing a year or two; but it is much better to submit to two or even three years' delay, than for a hundred years to have bad fruit.

The motives of preference, for the purpose of making good cider, have been already discussed; but it may be as well here to observe that too great a prevalence of pale and green fruit in an orchard might in many cases be corrected, as affects the cider, by obtaining crabs or wildlings to mix with them, wherever they can be obtained, as they give an agreeable acerbity to the cider, while they check the tendency to excessive fermentation, and adapt it for keeping longer without change. This practice is very common in Ireland, where, it is said, excellent cider is produced by this means. Less is thought of there with regard to the selection of fruit for the orchard, and perhaps this disregard may in some degree arise from the corrective practice above alluded to. However this be, there can be no doubt that the kind of fruit must have a very considerable influence on the quality of the cider, though the soil upon which the fruit is grown, and the skill exercised in making it into cider, are probably more influential.

Pears.

The pear-tree will grow, and produce great crops of fruit, on soils which are not favourable to apple-trees. For instance, on drier and lighter soils, consisting chiefly of sand. In Worcestershire, Herefordshire, and Gloucestershire, they are often planted in hedgerows; and from such trees the farmer frequently derives a large supply of excellent perry. The trees of the perry-pear are some of them so large that one will, in very favourable seasons, produce several hogsheds. There are, however, some objections to the practice of planting fruit-trees in hedgerows: they shade the land, are exposed to depredation, and require the exclusion of cattle during a considerable portion of the autumn. But we ought

to set against these objections two countervailing advantages: the ditches of a field receive a great deal of nourishing matter from the drainage of the land, which readily finds its way to the roots of the trees; and the sun has freer access to the trees so situated than when they are crowded together in orchards. Pear-trees are but little cultivated in the counties of Somerset and Devon, at least for the making of perry, which is the more remarkable as the soils of both counties must be equally favourable to their growth; but as the pear-tree is many years before it comes into bearing, this neglect may have arisen from the nature of tenures. A tree which requires twenty years to bring it into bearing should be planted by the person who is in possession of the fee of the land, or it is not likely to be planted at all.

The best perry-pears are generally very harsh and disagreeable to the taste, and indeed may be considered uneatable, so that even hogs are said to reject them; and yet they produce, when ground, very sweet pulp and rich juice. The sweet eating pears make a much inferior perry, which soon turns sour.

The mode of raising pear-trees is precisely similar to that of apples. Stocks may either be raised from the wild pear or from the seed contained in the pulp after making perry; nor is there so much reason to prefer the wild kind to the perry-pear as the crab-stock to that raised from the apple-seed. A repetition of the process is therefore needless, and particularly as they are most generally purchased from the nurserymen, to whose department the business of rearing more properly belongs, and by whom it can be better executed. It may be observed, however, that the pear will succeed if grafted upon the apple, service, medlar, or quince stock. Some pears are said to be improved by being grafted upon the latter, but the hard sorts are rendered gritty.

The several kinds of pears cultivated in the counties of Hereford, Worcester, and Gloucester, for perry, are principally the Longland, the Squash, the Oldfield, the Barland, the Sach Pear, and the Red Pear. The following are described and recommended by Mr. Knight as the best of their kind:—

Oldfield Pear. . Green; round; small; very productive.

Forest Styre Pear.

Longland Pear . . Much valued; getting rather old.

Holmore Pear . . Plentiful bearer; small; round; very good for perry.

Huffcap Pear . . Green, tinted brown; small; very austere.

Barland Pear . . Green; small; somewhat egg-shaped; trees very large and handsome; produce great.

The following are amongst the best eating pears:—

Little Musk Pear Yellow; early.

Red Muscadelle Yellow and red; large; beautiful,

Jargonelle Rich musky flavour; early,

Great Blanquet	
Musk Robine	Yellow; rich; great bearer.
Holland Bergamot	
White and Grey Monsieur John.	Very fine.
Rouseline Pear	Very juicy and good; late.
Crosane Pear	Very good and fine; late.
Brown Buerrie Pear	
Swan's-Egg Pear	Green, or brownish; small.
Golden Buerre	Rich scarlet.
Red Orange Pear	Greenish and purple; rich flavour.
August Muscat	Light yellow; smooth; excellent summer fruit.
Summer Bergamot	Rich and juicy.
Autumn Bergamot	Rich; juicy; highly perfumed; great bearer.

Before we quit the subject of rearing plants, it may be well to observe that it is a common practice, after the plants have been removed to wide rows, to cover the intervals thickly with furze, when it is readily obtainable, which prevents the growth of weeds, keeps the ground moist, and, as it decays, yields manure to the trees. It would perhaps be a better practice to raise two or three successive crops of manured potatoes.

Planting Out.

When the trees have shed their leaves is the most proper time for planting out. They should be taken up with their lateral roots at least two feet in length, and planted as soon after as possible. In planting orchards, the ground, for the space of at least 6 feet in diameter, should be trenched to the depth of 16 or 18 inches, and well broken by the spade or mattock, the turf being thrown to the bottom. It is of some importance that the tree, when planted in the orchard, should stand in the same position, with regard to the points of the compass, as that in which it grew in the nursery; and, in order to ensure this, the south or north side of the trees should be marked before they are removed from the nursery, and this might be done when trees are purchased at the time of selection. Care should be taken to surround the roots with the finest part of the mould, and to plant the trees at precisely the same depth as that at which they before grew. The ragged or lacerated ends of the roots should be taken off with the knife; and the hole, after being duly prepared as above, opened wide enough to admit the longest of them. If the ground at the time of planting be dry, and water can be conveniently procured, two or three bucketsful, applied to each of the trees, will be of essential service in securing its growth. The tree being placed in the hole, and temporarily fixed in its proper position by a single stake, the hole should be nearly filled with mould, and the

water poured upon it. After a few hours, the remaining mould may be added, and well trodden down.

The mode of fencing must be suited to the kind of stock kept in the orchard. If sheep only are depastured, the tree should be closely surrounded by strong thorns stuck into the ground, enclosed and sustained by thick stakes driven into the firm ground beneath, and reaching nearly to the forks of the tree, and these firmly held together by strong bands or withes. As a further precaution against damage from the gnawing of sheep at any exposed place, the trees should be washed or smeared with a mixture of creamy lime and cow-dung, which should be renewed from time to time as occasion may require. If it be indispensable to stock the orchard occasionally with large cattle, the tree must be fenced by two or three rough strong posts, fixed firmly in the ground, and united by strong battens or short rails nailed to each, and embracing thorns or furze closely surrounding the tree. It is a miserable economy to perform this part of the business of planting imperfectly or scantily, as many an orchard has been ruined by the neglect of proper and substantial fencing. In some situations, where flat slaty stones abound, the trees are sometimes surrounded by a circular wall. The trees should be planted at the distance of from 40 to 60 feet apart, according to the richness of the soil; for it should be always remembered that the roots extend far beyond the branches. At 42 feet distance, 25 trees will stand upon an acre, which may be generally considered the proper number. The rows should run north and south, in order that the trees may derive the greatest benefit from the sun. If in the ensuing spring a thick dressing of a well-mixed compost of lime and earth be laid over the whole space that has been opened round the trees, and afterwards dug in, it will be highly beneficial to them; and digging or forking round the trees should be repeated every year, for three or four years. If the ground be wet it should be thoroughly drained by deep covered trenches between each row of trees; and if, besides this, the whole ground were trench-dug, and the turf replaced as the work proceeds, if grass-land, or trench-ploughed if arable, the expense would be well repaid by the rapid growth of the trees, and the improvement of the land.

The benefit derived to apple-trees from deep digging, and a consequent permeable state of the soil, is strikingly manifested by the rapid progress and early bearing of orchards which succeed the cultivation of hops, a particular instance of which I have noticed in my own experience, and which is mentioned in my treatise on the '*Planting and Management of Forest Trees*,'* in-

* This paper had the name of *Charles Falkner* affixed to it by a mistake.

sented in the third volume of this Journal. The effect of moving the soil to a great depth, by taking up the beds of stone in the lias stratum, was also mentioned. In such cases, the trees in a very few years produce great crops of very fine fruit. These instances of the accidental deepening of the soil, and the effect produced by it upon the growth of apple-trees, I witnessed on the estates of Lord Portman, in Somersetshire, to which property, as an agent, I once rendered some slight services.

It has been observed before that the extensive culture of apple-trees is chiefly confined to certain districts, which abound with marly and heavy calcareous soils; and the probable and principal cause of this partial distribution has also been noticed;—namely, that such soils contain in greater abundance those mineral substances which are essential to the growth of the tree, and more especially to the formation of the juices of the fruit. It has likewise been observed that the natural impediments in other soils to the successful cultivation of the apple are removed by a liberal supply of ordinary manure, but particularly the fallen leaves of trees, in all of which potash is very abundant. The soil of the London clay, though not naturally favourable to the growth of apples, is, by trenching and manuring, made to produce not only plentiful crops of apples, but also all other juicy fruits in great abundance and perfection: and this triumph of cultivation over the impediments of nature is manifested in the highest degree in the extensive gardens that surround and supply the metropolis.

The extensive system of leaves of all fruit-bearing trees is probably quite adequate to the supply of all the organic or gaseous substances which both the tree and the fruit require, and therefore it is in the mechanical state and to the inorganic constitution of the soil that we must look for those conditions which are either favourable or unfavourable to the growth and productiveness of such trees. It is not enough that the soil be neither too open nor too retentive for the supply of the due degree of moisture; it must also contain those inorganic or mineral substances which the tree and the fruit require. When the defects are known, the remedies are obvious. By draining and trenching only, a stiff soil may probably be rendered favourable to the production of fruit; and, if this mechanical operation (at all times beneficial in such soils) fails to produce the desired effect, it is evident that mineral manures are wanting, which may be supplied by heavy dressings of lime or peat ashes, or both. If the soil be too porous, a heavy dressing of marl is the best remedy; and when this cannot be procured, clay, with lime and peat or other ashes, will supply its place. There are but few situations, however, where it would answer, except on a very small scale, to render light those lands capable

of bearing apples. It has been observed before, that marls, besides carbonate of lime, contain also potash and sulphate and phosphate of lime. Lime and peat-ashes generally contain more or less of the same substances, and in applying them to soils which do not contain them, or in which they are defective in quantity, we only supply the deficiency of nature. Every farmer knows that no soil can be productive without a plentiful supply of water; but those principles or substances which water conveys to plants, and which are equally essential to their existence, have hitherto, for the most part, as separate substances, escaped his observation, obscured as they are in the general mass of manures which he conveys to his fields. The fertilising effect of certain salts, which constitute only a part of this manure, and which till lately were never thought of as forming a necessary part of the food of plants, has awakened that spirit of inquiry which promises to lead, at no distant time, to a knowledge not only of the cause of the fertility and barrenness of land, generally speaking, but also to a more exact knowledge of the peculiar adaptation of certain soils to particular plants: in other words, the true reason why any particular plant will thrive in one soil, and not in another. That most ingenious and thoroughly practical people the Chinese have long since experimentally discovered the means of adapting their soils to the plants they wish to cultivate upon them, and provide the proper manure for each particular plant. We have much, therefore, to learn in this particular, at least, from a people whom we have been accustomed to regard as semi-barbarians—as, indeed, in some respects they are. Science has recently opened to Europeans a shorter and surer way of gaining knowledge of this kind, or at least affords them a guiding light by which to conduct their experiments, in the exact analyses which may now be obtained of plants, and of the soils upon which they grow and prosper.

These observations upon the artificial adaptation of the soils to the growth of apple-trees are merely thrown out as suggestions. There are, however, many analogous facts in the experience of agriculturists which are calculated to render them worthy of consideration. Clovers cannot be grown upon many soils without the application of ashes; and the produce both of turnips and wheat has been greatly increased by the application of bone-dust and other manures of a mineral character. Large tracts of country, once thought incapable of producing corn of any kind, have been made, by the application of proper manures and skilful management, to contribute millions of quarters to the general stock; and yet we are perhaps only arrived at the threshold of improvement in this department of agriculture.

When young trees have been carefully planted and well-fenced,

they will require but little attention, except that of keeping up the fences and taking care that they be not shaken by the wind. To guard against the latter, the tree should be well armed with a firm bandage of straw at the part where it rises above the top rail, and there confined between two cross-pieces, passing from one rail to the other, or else so firmly fixed by wither bands as effectually to prevent any rubbing, and consequent injury to the bark.

The bearing capabilities of apple-trees of considerable age may be much improved by judicious pruning, in removing decayed branches and old unprofitable boughs, where the head is much crowded. These should in all cases be taken off by a clean cut close to the branch from which they are separated, or at least to a lateral shoot, so that the part may heal over as soon as possible. By pursuing such a course of pruning, and by keeping the body of the tree only just sufficiently open to admit the sun to penetrate, the weight of the fruit will be increased, and it will at the same time ripen more regularly. Mr. Knight recommends most attention to be paid to the lateral branches, which, if unchecked by occasional pruning, are apt to load the tree too much at the extremities. In damp situations trees are often covered with moss, and thievish mistletoe takes root in their branches, and robs them of their juices. These parasitical ornaments should be perseveringly removed from the trees, though they are often suffered to grow with their growth, and strengthen with their strength; or, it might be more properly said, at the expense of their growth and strength. Sometimes trees, which at first were good bearers, become stag-headed and unfruitful. It is more than probable that this condition is owing to some defect in the soil. The proper remedy to be resorted to in this case is what is called heading-down—that is, removing all the branches to within a foot or two of the main forks or the stem of the tree, in order to encourage the formation of a healthy and vigorous head. This operation should be accompanied with a heavy dressing of compost, formed of lime, ashes, and earth, extending for a considerable distance round the tree, which should be dug in with the marled turf. If the land be wet, draining must be resorted to, as in that case other trees are no doubt suffering in some degree from the same cause. If the tree be infected with canker, the same treatment should be adopted; but in this case there is but little hope of success, for, according to Knight, that disease is symptomatic of the declining age of the species, which no treatment can effectually cure, except in the case of trees which have been grafted in the head. Fresh grafting, if the stocks be young, will remedy the evil. In otherwise hopeless cases, such treatment of stunted trees is deserving of trial; for, if it succeed, a large and full-bearing

tree is soon obtained; whereas, if it be removed and a young tree planted in its place—even if it succeed, which would be doubtful—it would be a long time before it came into bearing.

When the fences are no longer deemed necessary for the support and protection of the young trees, it is still proper to guard against the injury from cattle, by smearing the stems with lime and cow-dung.

In Herefordshire it is very common to plant apple-trees in arable-land—a practice the policy of which is very doubtful; though there can be no doubt that the trees must derive great benefit from the tillage and manuring of the land. I am not aware that any comparison has been made between the profits of an orchard under tillage and another in pasture, on the same kind of land. Indeed it is hardly likely that any trial of the kind has ever been instituted, or could be with any chance of a satisfactory result. It is highly probable, however, that many soils which are not naturally adapted to the growth of apples are rendered productive of them by means of the tillage and appliances which corn-crops require, and especially by the application of lime. Trees will grow luxuriantly on certain soils without bearing apples: on the deep gravels of the grauwacke slate, for instance. On such a soil I have seen an orchard planted upon pasture, the trees of which thrive well, but produced no fruit. There can be but little doubt that this orchard would have produced apples under an ordinary course of tillage and manuring. It cannot be for want of humus that such orchards are unproductive, for that accumulates in grass-growing orchards; nor can it be owing to a deficiency of either carbon or ammonia, or the elements of water, for of these the atmosphere affords an inexhaustible supply to plants which have large volumes of leaves and extensive roots for their absorption, and this supply is renewed by every breath of wind and every shower of rain. It must therefore be owing to a deficiency of mineral substances in the soil, which perhaps the ordinary manuring and liming bestowed upon arable land would have supplied; for the *constant* barrenness of an orchard cannot be attributed to the effect of spring frosts.

Other fruit-trees, besides apples and pears, may find a suitable place in an orchard attached to a farm-house. Plums and cherries may find a place on its southern side; and walnuts and Spanish chestnuts serve as a protection to the north and east. Cherries and plums are far less choice than apples, as to the soil upon which they grow. Productive orchards of the former are found upon the new red sandstone of Worcestershire, as well as upon the slate rubble of the valleys of Devonshire and Cornwall. In the vicinity of or at a moderate distance from large towns the produce of such trees often sells for a large sum of money.

Management of Store Fruit.

Apples and pears, which are intended for keeping, should be hand-gathered when they are as ripe as they will hang on the tree. If they are taken much earlier they will shrivel, notwithstanding all the pains that may afterwards be taken to preserve their plumpness. The gathering should be conducted with great care, so as to prevent bruising, as the least injury of that kind produces decay and rottenness in the injured apple, which soon communicates it to others. The fruit should be gathered in dry weather, and spread singly upon a floor in an open apartment for about a week, and then carefully put away in bins or boxes, in a tolerably airy place, with a layer of fresh dry wheat-straw, or of paper, between each layer of apples or pears. If it be desired to keep them very long, and in high perfection, when taken from the floor they should be carefully wiped, and each wrapped in thin paper, like that used for oranges. Recesses, fitted with shelves, so as to prevent their pressing too heavily, are the best adapted for their stowage. By the latter means, apples and pears of the keeping kinds may be preserved quite fresh and plump until the return of fruit in the following summer.

Making Cider.

Before entering upon the subject of cider-making, it may be proper to offer some observations on the nature of the apple with reference to that object, and also on the nature of fermentation—the right understanding of which is calculated to throw some light upon the best practice, and perhaps to lead to a correction of that which is bad. “Previous to maturity, apples are formed of a compact cellular tissue, containing the elements of woody fibre, and filled with a liquid containing very little sugar, a gummy substance, and a large quantity of free acid. During maturation a part of the acid disappears by the influence of the oxygen of the atmosphere, the cellular tissue diminishes, and the proportion of the sugar increases, insomuch that, instead of hard woody acid fruits, we obtain, if the maturation have been complete some weeks after gathering, fruits which yield a sweet and sirupy juice.”* The juice of the apple and pear, as well as that of the grape, gooseberry, currant, and other juicy fruits, contains, besides sugar, a substance called vegetable gluten, and, more commonly, ferment, because when acted upon by the air it excites that peculiar action called fermentation. This substance is much more abundant, or at least is much more active, in the expressed juice of unripe fruit than when it is arrived at perfect maturity.

* Liebig.

It is material to notice this increase of the saccharine matter, and the decrease of gluten, or fermentive principle, as the apple advances to perfect ripeness, as these circumstances exercise a most important influence in the manufacture of cider. When apples fall from the tree, though ripe in the common acceptation of the word, they are not arrived at that maturity necessary to the production of the best quality of cider, or rather of that cider which is most generally desired, and which possesses an agreeable combination of sweetness, acidity, and spirit. If the juice be expressed from the fruit out of contact with the air, it may be kept for any length of time in a close-stopped vessel without undergoing any change; but as soon as air is admitted the liquor becomes turbid, and begins to ferment.* It is in this way that fermentation is prevented in the fruit, the air being excluded by the compact rind of the fruit; but no sooner is this coat and the cells of the apple broken by bruising than fermentation commences, the fluid becomes brown, and decay of the fruit ensues.

When the juice is expressed from the fruit in the ordinary way for making cider, and placed in a tub or cask, exposed to the air at an ordinary temperature, it soon becomes turbid, enlarges in volume from being full of minute bubbles, which rise to the surface, bearing with them a scum, while a sediment falls to the bottom of the vessel. This is the action of fermentation. The change thus going on was commenced by the oxygen of the air uniting with the gluten of the juice, which thus becomes a ferment—that is, gluten in a state of change from a soluble to an insoluble substance, and is strictly of the same nature as yeast. In this state it becomes an exciter of change in the sugar, causing its elements to undergo new arrangements, by which they form alcohol, or spirit, which remains in the liquor, and carbonic acid, which escapes as gas. This change, if unchecked, will often proceed until all the sugar disappears, and the cider becomes harsh. If, instead of a deep tub or cask, the juice be placed in a shallow vessel, and kept at a low temperature, the gluten is then oxydized and precipitated, producing only a modified action on the sugar, owing to the low temperature, by which the latter undergoes a more gradual change. By the precipitation of the gluten thus produced the liquor is prevented from undergoing strong fermentation when put into the cask. It is this action of the air upon the gluten by which the latter is thrown down, that cider-makers avail themselves of when they wish to subdue or prevent excessive or violent fermentation.

If, as soon as they fall, the apples be immediately carried to the mill and crushed for cider, the juice drawn from them will be

* Gay Lussac.

comparatively poor in saccharine matter; while the ferment will be more plentiful, or stronger; both of which circumstances are calculated to produce rapid and violent fermentation, which it is difficult to check or control before all the sweetness is exhausted. If, on the contrary, the fruit be suffered to remain some days under the tree, exposed to the light and air, and when collected be placed in heaps, not exceeding eight or ten inches deep, either in the orchard or under airy sheds, and allowed to remain some weeks until they become quite mellow, four points will be attained favourable to the production of good cider. First, the water of the juice will be diminished; second, the ferment will become less powerful; third, the saccharine matter will be positively increased; and, fourth, the season of the year will become cooler and more favourable to a moderate degree of fermentation. Poor apple-juice, like thin wort, ferments quickly, and afterwards, when exposed to the least air, at a moderate temperature, is apt to turn sour; while rich juice, as well as strong wort, ferments slowly; and the more active degree of fermentation is soon checked by the production of a greater quantity of vinous spirit, the presence of which has a strong tendency to subdue that action, and to bring the liquor to that state in which further vinous change takes place slowly. After the sugar of thin cider is exhausted by fermentation it still retains a considerable quantity of gluten, or ferment; this, having no sugar to act upon, now promotes the change of the spirit into vinegar, or acetic acid; a change which takes place with greater or less speed according to the degree of temperature and of exposure to the air—for instance, under a slow draught and in a warm situation. Cider made from richer juice is for a long time protected from the acetous change; for after the more active fermentation has ceased, a large portion of the sugar is left unchanged in the liquor, upon which the still slowly-precipitating gluten, or ferment, acts to the preservation and increase of the spirit.

It is well known that, during the operation of grinding, the pulp of apples and pears becomes much sweeter; and by a further exposure to the air the sweetness is still further increased. Some exceedingly harsh pears yield quite a sweet pulp by mere grinding. This change appears to be of a similar nature to that which takes place in the conversion of starch into sugar by the action of bruised malt, and is probably due to the same cause—the presence of air, moisture, and gluten.

The above explanations, it is presumed, are calculated to throw some light upon the operations of cider-making; and, by dispelling in some degree the mystery in which, as a practical art, it is involved, to lead to clearer views and more certain results.

In the west of England and in Ireland, apples are generally

ground by means of what is sometimes called a nut-mill—that is, two wooden rollers, thickly studded with strong blunt pegs of iron, and revolving in opposite directions, with a hopper to supply the apples, and generally turned by horse-power where there is any quantity of cider to make. The imperfection of this mill, notwithstanding some improvement it has in some cases undergone to give the pulp additional pressure, is, that the pulp is not sufficiently broken, and the pips or seeds are for the most part untouched, both of which are very objectionable circumstances. In Herefordshire the apples are crushed by a large circular stone revolving in a circular stone trough, and drawn round by a horse. By this means the apples are more completely broken, and most of the seeds crushed, while the pulp is more effectually exposed to the action of the air, a matter of no small importance in the manufacture of cider. Formerly, the cider-press was an enormous fabric of wood, consisting of two massive pillars fixed in the ground, and connected by a sill or bed below, and a cross-beam above, which received the immense wooden screw, and both morticed through the pillars. A platform or bed of wood, deeply grooved round the edges and across the centre, with a lip to discharge the juice, rests upon the sill—this is about three or four feet wide; a broad wooden plate attached to the screw, with a long wooden pole, a capstan, and rope, complete the apparatus. Such may even now be seen lingering in some remote districts, but they have for the most part given way to more compact machines, with iron screws and posts or pillars, and so contrived as to render a common iron bar effectual without the aid of a capstan. A low long wooden trough receives the juice as it runs from the press. In apple countries, a cider-house supplies the place of a brew-house. It has generally a loft for the reception of the apples. Where much cider is made, a long building is generally attached, so contrived as to admit a free access of air, in which the cider is fermented, and sometimes stored. For either purpose the building should be thatched, and made capable of being rendered open or close, as the season requires.

The ordinary process of making cider, where it is not intended for sale, but merely for the consumption of the farm, is very simple. Quantity, rather than nice flavour, is the object most regarded. As the apples fall they are collected, without selection, into heaps in the orchard, where they remain till they are mellow. They are then carried to the mill, and, when ground, the pulp is placed in a layer, about three inches deep, upon the bed of the press, a horsehair cloth having been laid under it; the edges and corners of the cloth are then folded over the sides of the pulp, another cloth is laid on for another layer of pulp, and this is repeated till there are about ten or a dozen layers. In order to keep

these layers of one size, a frame is generally used, which is drawn up as the work proceeds. Sometimes clean straight wheat-straw is used, instead of haircloths, the ends of which are bent over the incumbent layer of pulp; but this, on many accounts, is a much less convenient method, though it is a saving of expense. When the pile of pulp (or cheese, as it is called) is completed, the press is applied, gently at first, and gradually with increasing force, at considerable intervals, until no more juice can be extracted with the utmost power of the screw. The cheese of pommey is then removed, to make way for another charge of the press.

When straw is used instead of haircloths, towards the close of the work the screw is eased, and the ragged and projecting edges of the cheese pared off with a sharp instrument, and the parings placed upon the top of the cheese, when the pressure is renewed. The dry pommey, or pulp, is thrown into water, where it is allowed to macerate; and when the other cider is made it is again pressed, and affords a weak but sweet cider for present use, called ciderkin, or water-cider. The pulp of three hogsheads of the first cider will produce about one of the water-cider. The juice is taken from the press and put into casks, leaving a considerable hullage or space beneath the bung, and when it has fermented and become fine the cider is racked off the lees into other casks, and stowed away for use, leaving the bungs loose until there is no danger of a renewal of the fermentation, which might endanger the barrels if closely stopped at first. In many cases, even less pains are bestowed, and the cider remains in the same casks in which it was fermented until required for use. This is the general outline of the operation of making common domestic cider, but the practice differs more or less in every cider district.

The cider produced in this way is generally a rough strong drink, which is however generally preferred to sweet cider by those who make it their constant and almost only beverage. There is one good reason for this preference, which is the superior strength of such cider, as it has of course more spirit than that made from the same juice which has by management been prevented from fermenting to the same extent, and therefore remains sweet. The habitual cider-drinker prefers the exciting quality to the sweetness of the liquor.

In the manufacture of the sweet and more palatable cider, and those of superior quality, intended for bottling and sale, considerable care and attention is required. After what has been previously stated with regard to some of the chemical properties of fruit, and of the fermentation of its juice, the motives for the different operations of the practical cider-maker will be better understood. The following, in the leading particulars, is, according to Mr. Knight, the practice of the best cider-makers in Hereford-

shire, though in many respects the practice differs materially in different districts.

As the fruit falls, it is collected in heaps of about eight or ten inches deep, or is conveyed to an open airy shed or apple-loft. In collecting the apples for making the best cider, the green fruit is thrown aside. In these heaps the apples should remain some weeks, until they become quite mellow. When conveyed to the mill all the decayed fruit are picked out. The pulp is thoroughly broken down by the action of the mill, not only for the more perfect extraction of the juice afterwards by the press, but also for the free admission of the air to every part of it. With this view the grinding should not be a hurried, but rather a slow operation; for the more the pulp is exposed to the action of the air, the more saccharine it becomes, and the cider will be the less liable to violent fermentation in the cask. The pulp is allowed to remain exposed to the air four-and-twenty hours before it is conveyed to the press, in order to obtain as large an absorption of air as possible. In some instances the pulp is only slightly pressed, again spread to the air for some time, and afterwards returned to the expressed juice and pressed again. With such or similar preparations as the above, the increased richness of the juice, the diminished energy of the ferment, and the low temperature of the season, are all favourable to that moderate degree of fermentation which is requisite for making sweet cider. When the liquor is put into the casks a considerable hullage or space between the bung and the surface of the liquor should be left, to allow a freer access of air, and the casks should be placed in an open and airy place, as in confined places or cellars the cider ferments too rapidly. If, notwithstanding this precaution, the fermentation becomes very active, the liquor should be immediately racked off, and the operation repeated if it again occurs. The too great activity is indicated by a loud hissing noise, which is heard upon applying the ear to the bung-hole. The fermentation sometimes commences in a day or two, and at others not for many days, or even a fortnight or three weeks, according to the strength of the juice and the temperature of the season. When the fermentation has ceased, which may be known by the liquor becoming clear, it should be immediately racked into well-scalded and dried casks; these casks, as before, should not be quite filled, and their bung-holes merely covered. Great attention should be given to prevent any recurrence of active fermentation; upon the least appearance of which racking must instantly be resorted to, until the cider becomes permanently tranquil. The dregs of the fermenting casks should be filtered through a conical flannel-bag, spread at the mouth and suspended by a hoop. In the operation of racking, the finer the stream the more effectual will it be in

checking fermentation; and this effect will be increased by pouring the liquor through a vessel perforated with numerous holes, or affixing the rose of a watering-pot to the vent or tap, thus producing a more complete separation and exposure to the air, and consequent precipitation of the ferment. Some cidermakers cause the cider to run down a board into the receiving vessel, so as to expose it as much as possible to the action of the air.* The object of all this particular management of the cellar is, after obtaining a certain degree of fermentation necessary to produce a sufficient quantity of spirit, to subdue the action of the exciter, the ferment, and thereby to induce that slow and tranquil change which gradually converts the remaining sugar into spirit, but which, in a well-closed cask and a cool cellar, it takes years to accomplish. In the following April the cider is again racked, to get rid of the lees, and the casks are then closely bunged down, and the cider is in a fit state to stow away in the proper keeping place, or to send out.† When perfectly fine the cider is fit for bottling; but Mr. Knight recommends keeping it two years before it is bottled. Cider, carefully managed, will retain its sweetness three or four years in the cask, and many years when bottled. The bottles should be laid upon their sides, in order that the corks may swell and prevent the escape of the gas. In bottle, the gas, which at first is yet slowly formed, soon occasions such a pressure as to put a stop to any further change, which can proceed only so long as the carbonic acid gas—one of the products of that change—is allowed to escape. In tolerably matured cider, the needful pressure for this effect is too feeble to endanger the bursting of the bottles, but is at the same time sufficient to give great briskness to the cider when the cork is drawn.

In tracing the progress of these operations, and that of the cider to its perfect state, or rather to that state which is considered desirable, it may be observed, with regard to the cause of the changes which take place, the gluten or ferment, that its quantity is so great in the juice of imperfectly ripe apples, in proportion to the saccharine matter, that when pressed at that time, and allowed to ferment, the action would be so powerful as soon to exhaust all the sweetness, and produce a harsh cider. By the more perfect ripening of the apples, and the slow grinding and exposure of the pulp to the air, the power of the ferment is very

* The coolness of the situation of the cider during its fermentation is of great importance; for at a temperature much above 50° Fahrenheit, the acetous change commences, and proceeds simultaneously with the vinous: but below that degree, neither before the cider is tunned, nor after in the open cask, is any acid produced.—*Author*.

† The racking of cider in the spring should be performed when the air is dry and cool.

much diminished ; and so much of it is afterwards removed by the modified but still active fermentation in the cask as generally to prevent the recurrence of it, at a low temperature, after it is racked. If at this stage the active fermentation does not recur, that gradual change succeeds by which the ferment still in the liquor is slowly deposited, and a corresponding change of sugar into alcohol or spirit takes place. As this proceeds there is less and less danger of the renewal of active fermentation from a change of temperature, till ultimately all danger is removed both of that and the acetous change by the removal of the cider from the deposited ferment, or lees, when it is racked in the spring, and the exclusion of the air. From this period a continually diminishing action of the same nature proceeds, producing the effect called ripening.

The great change which takes place in fermentation is, as before stated, the conversion of the sugar of the liquor into alcohol and carbonic acid gas, and the ferment is the exciter of this change, which would not take place without its presence. The more, therefore, the active power, or the quantity, of the latter is diminished by the ripening and treatment of the fruit, and afterwards by racking, which is calculated to render it inert, the greater will be the quantity of sugar which remains unaltered. The influence of the richness of the must, or juice, in checking the energy of fermentation has been already mentioned. I make no apology for this apparent repetition, because it is very desirable to possess clear ideas of the nature of fermentation, as far as it is known, and of the effect of the means resorted to for the purpose of managing and controlling it. The use of sulphur-matches—that is, strips of canvas dipped in sulphur and burnt within the cask previous to racking, for the purpose of checking the fermentation—is liable to great objection, as it gives an unpleasant flavour to the cider, and is at best only a substitute for more careful management.* A small quantity of powdered charcoal has been lately stated to arrest fermentation without imparting any flavour. It is better to depend upon good and careful management than upon such adventitious helps. It has been observed, that juice pressed from unripe fruit at an early season of the year runs rapidly through its fermentation ; and it is at the same time, owing to a higher temperature, liable to contract acidity. When therefore it becomes necessary, from any cause, to make cider at any early period, the utmost attention must be given in order to avert these consequences. The liquor should

* The application of brandy or other strong spirit will not prevent acidity, but ultimately increase the quantity of acetic acid if the gluten be not previously removed, and in any case it is objectionable.

be put into small casks, and placed in a very cool situation, and active fermentation prevented as much as possible by repeated racking. Coarse brown sugar would enrich the juice and exhaust the ferment; and frequent mopping the cask would lower the temperature. If these operations should be thought too troublesome or expensive, the maker must be content with very harsh cider. Apples are stated, by persons who have made exact experiments, to yield about 70 per cent. of their weight of juice; or, 7 gallons of juice to 100 pounds of apples: which may serve as some sort of guide to those who may wish to purchase apples for the purpose of making cider.

As the strength of the cider always depends upon the weight of the juice, there is no surer way of ascertaining the value of apples, so far as strength is concerned, than the use of the saccharometer, the instrument which brewers use for ascertaining the strength of their worts. The weight of distilled water at the temperature of 60° is the standard of comparison, and is called 1000. The instrument is a copper ball with a graduated upright shank, which, by placing a weight (a round flat piece of brass with a hole to admit the shank) upon the top of the ball, is made to indicate the excess of the weight of the same measure of wort above that of water. The weight thus indicated is called its specific gravity. A juice with a specific gravity of 1080 is considered very strong, and is equal to a wort that will make strong ale. Mr. Knight mentions an excellent apple called the Golden Harvey, the juice of which had a specific gravity of 1095. The weight of apple-juice might be ascertained with tolerable accuracy by means of a Florence oil-flask, and exact scales and weights, with the help of a few figures, or by comparison merely, without figures. Little advantage, however, can be made of such a precise knowledge of the weight of apple-juice, which, after all, will differ very much with the season, and is also influenced by the time the apples are kept before grinding, by which the juice is enriched at the expense of quantity.

The mode of making perry differs very little from that of making cider. The fruit, however, is pressed as soon as gathered; and the roughest pears generally produce the best perry. The perry produced from sweet pears, which have no astringency, soon turns sour. Crabs are said to be sometimes used with pears, which have a tendency to improve the keeping quality of the perry. The same precautions are used as in the case of cider to prevent rapid and excessive fermentation; and the fermenting juice is often racked before it has ceased to ferment, in order to prevent it going too far.

Though great pains are taken in the manufacture of cider in-

tended for sale, in order to enhance its value, it is still quite an empirical art, and consequently the practice varies very much in different districts. The best practice (that is, such as produces, upon the average of years, the most valuable cider from the same fruit) will perhaps admit of but little improvement from the application of scientific principles; but if that practice be more conformable with scientific views than others, its claim to preference is strengthened and confirmed by reason, while such views may suggest, to a discerning and experienced operator, some means of valuable improvement in his practice.

So great is the difference in the value of cider, arising from the choice of fruit and the mode of making combined, that a gentleman near Ross, mentioned by Marshall, some years ago produced a cider so valuable that he was offered 60*l.* for 110 gallons, or an equal quantity of good foreign wine. This cider is said to have been produced from the Hagloe Crab, and the mode of making it differed from that generally practised in this—that the juice was fermented in wide vessels not more than two feet deep, and the cider carefully drawn off from the dregs beneath and the scum above, and put into casks without anything more being done to it. It is much to be doubted whether this is a trustworthy account of the means by which such excellent cider was produced. We are not told anything of the temperature of the place in which the fermentation was conducted, nor of the time required for the desired change in such shallow vessels. The temperature, in all probability, was quite low, and the time considerable; and the process very much resembling the slow kind of fermentation mentioned by Liebig, which a peculiar beer, produced in some parts of Germany, is made to undergo. It is much to be regretted that Mr. Marshall, or the worthy Man of Ross himself, did not furnish the world with every particular of his method of making this superlative cider.

While passing through the press, the proof-sheet of this paper was submitted to the inspection of Dr. Ure, who told the author that the views and reasonings therein given are quite correct, and in perfect accordance with the science of organic chemistry.

XXIX.—*On the Solution of Bones in Sulphuric Acid for the purposes of Manure.* By the DUKE of RICHMOND.

To Ph. Pusey, Esq.

MY DEAR PUSEY,—I have not yet received the details of the experiments tried by the Morayshire Farmers' Club with sulphuric acid and bones, but I know that the result has been most satisfactory. On my own farm, which is light sandy soil, I tried one acre with it, another with guano, and a third with stable-yard dung. Early in November I had a quarter of an acre of each drawn and weighed: the heaviest crop was from the land manured with the sulphuric acid, though it did not cost me above 11s. or 11s. 6d. an acre.

I understand also that the turnips came into rough leaf sooner on that acre than on any of the others.

Believe me yours sincerely,

RICHMOND.

London, December 9, 1843.

NOTE.

The experiment contained in this letter bears out those of the Morayshire Farmers' Club, the details of which appeared in the last Journal, and affords good hope that this, the most important saving which was ever held out in the use of manure, will be found generally applicable. For those details I must refer to that paper, merely mentioning now, that in one trial a bushel of bones to which sulphuric acid had been applied, exceeded in its effects six bushels used in the common way. As this is the first instance, I believe, in which chemistry has assisted practical farming, it may be interesting to examine the theory on which this application is founded. Bones may be roughly stated to consist of fat, of jelly, and of an earthy matter, called phosphate of lime. When they were first employed as manure, it was doubtful of course to which of these substances they owed their beneficial effect, and many persons were unwilling to purchase bones which had been boiled, and had consequently lost their grease. It was soon found, however, that boiled bones were as good manure as those that were unboiled. There still remained in the boiled bones two substances, either of which might be their active principle. But Sprengel states that he found bones which had been not only boiled, but burnt, still act as manure; and Mr. Hannam has tried the same experiment with the same result. Now as fire drives out of the bone the solid jelly which holds it together, there remains only the earthy matter behind, thus proved to be the ma-

nuring substance. This being phosphate of lime, chemistry suggested that since the lime was in so small a quantity, the phosphoric acid united with it must be the true manure contained in the bones, and that if the lime were taken from it by sulphuric acid, the phosphoric acid thus set free would be greatly strengthened in its immediate activity. This the Morayshire farmers carried last year into effect, and the Duke of Richmond in the present year, the result wonderfully according with the predictions of chemical science. We cannot even now regard this discovery as completely established; but as it promises a very great saving to farmers who buy bones largely, I hope that the hint will be followed up until certainty has been attained. Hitherto the dissolved bone, or gruel, as one farmer calls it, has been mixed with large quantities of water, and applied as a liquid manure; but the use of any liquid manure is so laborious and inconvenient, that I should greatly prefer, as a trial at least, to mix the dissolved bones with some dry earth or ashes, which might be used by the ordinary method of drilling.

PH. PUSEY.

XXX.—*Statement of a new and successful Rotation of Crops for Heavy Clays.* By J. S. NOWLSON.

To Ph. Pusey, Esq.

SIR,—My course of crops is as follows, viz. one-fourth wheat; after that oats,* one-half of which is sown alternately with

* As a general rule applicable to much, perhaps most, of the soils of this country, the alternation of corn and green crops is better than two corn and two fallow crops in succession; but on land of the peculiar character of that in Northaw it is otherwise, and a comparison of Mr. Nowlson's crops with those grown on similar land in the neighbourhood, managed on the alternate system, sufficiently proves that that rule must not be taken to be without exceptions.

Nyn Farm is situated at the northern extremity of the extensive parish of Northaw, which is a border parish of the county of Herts. On the south is that wild part of Middlesex once Enfield Chase, but now enclosed and cultivated. The quality of the land in Northaw varies considerably, but its general character is that of a wet and singularly tenacious clay (on the plastic clay formation), interspersed in places with beds of rounded gravel. These beds are merely superficial—that is, few of them are more than 6 feet deep, and they have invariably the stiff clay beneath them. Chalk can in many places be reached, on Nyn Farm, at the depth of 60 feet; and about thirty years ago, when great part of the farm was enclosed from a state of common by Thompson of Northaw (a name well known to the readers of Cobbett), much chalk was raised, and used in bringing the land into cultivation, the good effects of which are visible to this day. The arable land has been completely drained with bushes, as is common in this district; and the drains having been laid at 18 feet apart, the land

clover; after that, sown with winter-tares, eaten off green by fatting sheep;* then a bastard fallow for wheat—the other half fallowed for turnips, part eaten on the land and part drawn off; then fallowed for spring-tares or coleseed, eaten off by fatting sheep; then ready for wheat again. For example, say if the farm be 200 acres of arable land—

50	acres	Wheat.
50	„	Oats.
25	„	Winter Tares.
25	„	Fallow for Turnips.
25	„	Clover.
25	„	Coleseed and Tares.

200 acres.

This is a system I have used for some years on strong retentive clay-soil, which I have found answer well.†

I am, Sir,

Your obedient servant,

J. S. NOWLSON.

Nyn Farm, Northaw, Herts.

is as dry as, from the character of the soil, is possible. Still the arable land is so tenacious, and its reduction to a tilth must be affected so much by the action of the atmosphere, that every plan for its cultivation should be arranged to avoid unnecessary trampling either with horses or sheep in wet weather.

The object, therefore, of Mr. Nowlson's rotation is to prepare as much of his land as possible in the summer and autumn months. For instance, the advantage of sowing oats after wheat is, that the wheat stubble, on being ploughed up in the autumn, remains rough through the winter, can be harrowed down to a fine tilth, and the oats sown in the very first dry week which occurs in the early spring. Experience has shown that nothing but early sowing can secure an abundant crop, and this could not have been done after the land had been trampled by sheep feeding off roots, &c.

Indeed the interval which intervenes in the spring of many years, between the time when the land is too soft to be worked, and when it has become excessively hard, is often so short, that unless the preparations for spring corn have been nearly completed in the previous autumn, those crops are with difficulty got in at all.—R. G. WELFORD.

* One half of all the green and fallow crops, except the clover, is fed off by ewes, and lambs fattened on corn for the London market. The other half is drawn off for other cattle.—R. G. W.

† I saw the principal field of wheat, of about 30 acres, on the day the reaping of it commenced (17th August, 1843), and a more splendid crop is seldom seen. It has been estimated by various competent judges who have seen it at considerably more than 40 bushels to the acre. This identical field, fifteen years ago, produced a wheat crop which *only averaged 6 bushels to the acre*. The wheat now growing is "Revetts," a bearded wheat.—R. G. W.

Northaw, Barnet, August 19th, 1843.

XXXI.—*On the proper Materials for filling up Drains, and the Mode in which Water enters them.* By ROBERT BEART.

ALTHOUGH I felt incompetent to give the extensive information required by the conditions for the Prize Essay on Draining, I wish to lay before the Council of the Society the result of my experience and observation in draining from 300 to 400 acres of cold clay land. In the first instance, without any practical knowledge, I commenced draining with the plough, wood, wood and straw, peat, block and turf or wedge draining, and at shallow depths with tiles; but the greater part of the land drained with the plough, wood, &c., is now re-drained with tiles. In the tile-draining, the depth at which the tiles are laid varies considerably, in some fields 12 to 15 inches, in others 15 to 20, again, 20 to 30, and in one instance, on a piece of very flat table-land (very difficult to drain), from 30 to 40 inches below the furrow; but if the land were laid level, the depth of the drains would generally be 6 inches deeper than stated.

I hope to show that the drainage of tenacious clay-soils is not as in the draining of gravel, peat, or other light soils, a mere practical operation, but must be considered in relation with the operation of under-drains by the aid of the atmosphere contracting the subsoil, and thereby increasing the size of the fissures, for the water to percolate to the drains, and also with the injurious effect arising from water lying in the land below the level of the drains (where these are shallow), rising by capillary attraction, expanding the subsoil, and partially closing the fissures, and thus checking the free infiltration of the water; so that attention to the operation of these agents, the infiltration of water, and the levelling of high-ridged lands, is of the greatest importance.

Having thus briefly introduced the subject, I shall proceed to illustrate it as follows:—

1st. The geological character of the clay soils of Huntingdonshire.

2nd. Depth and frequency of drains, &c.

3rd. Fall required, and the necessity of levelling high-ridged lands.

4th. Materials in this district best for draining.

5th. Filling-in, whether with tenacious or porous earth.

6th. The practical mode of draining clay land, lying wet from surface water, in which is considered the laying out the ground for the mains and small drains, with the cost of draining with tiles, wood, peat, turf or wedge, and block draining.

1st. *The geological character of the clay-soils of Huntingdonshire.* The clay soils extend over the greater part of the county, running from East to West, lying between the oolitic hills and

the chalk; the subsoil consists of a very retentive stiff clay, of a light colour, from 2 to 15 feet thick, enclosing small stones, shells, and nodules of chalk, rising generally to within 6 or 7 inches of the surface, and resting upon the Oxford clay, which is computed to be from 100 to 1500 feet thick, mostly devoid of sand or calcareous matter, containing surface-water only. The number of springs is so small as not to be worthy of notice.

2nd. Depth and frequency of drains, and their operation, in conjunction with the atmosphere, in contracting the subsoil, enlarging the fissures for the water to percolate freely to the drains, and preventing, in wet seasons, such an expansion of the subsoil and closing of the fissures as would hinder the free infiltration of the water; and that the drainage of land cannot be perfect where the water runs over the land and filters from the surface through the filling-in over the drain.

There is no part of cold clay land draining upon which greater difference of opinion exists than upon the depth at which the drains should be laid; the plan generally followed by persons without experience, or reflection upon the subject, is to lay the drains near the surface, on the supposition that they cannot be too shallow, if laid so as not to be injured by the horses, &c., in the necessary acts of cultivation; and a very general but erroneous opinion is entertained, that if under-drains are laid deep in tenacious clay soils the water will not enter so freely.* From experience I have found that the more tenacious the clay land to be drained, the greater should be the depth of the drains; for although, on some lands of a mixed soil, drains 20 inches deep may be effectual, they are very inferior to drains of 30 inches, or 3 feet for stiff clays, for the more pure and tenacious the clay, the greater is the contraction of the subsoil, when the water is displaced by the operation of under-drains and evaporation by the atmosphere, and the larger will be the fissures in the same to convey the water to the drains. On well-drained land the water does not enter the drain by the furrow, or from the surface immediately over the drain (or where the drain is not in the furrow, through the filling-in), but as it falls enters first the tilth or surface, and afterwards the fissures and the borings of the common earth-worm. The utility of the earth-worm in the drainage of land is unquestionable, for it loosens the soil by its boring operations; the bores of the worms alone on some grass-lands would be sufficient for the infiltration of the water, if the drains were laid a proper depth to carry it off. I have found

* An observation very general among cold land farmers, and which is considered conclusive against deep draining, is, that if a horse only sets his foot upon heavy land near the edge of the open furrow, the cavity will hold water like a basin. The cause of this is very evident: the horse on wet clay land will smooth the bottom of the cavity with his foot.

that the worms bore quite as deep as the main drains, and some of the bores are half an inch in diameter; these, combined with the fissures, admit the water to the depth they are formed; and if the fissures and worm-bores, after a continuance of dry weather, extend below the level of the minor drains, at the commencement of heavy rains the water does not run off, until the fissures and worm-bores are filled to such a height that there is a fall from these side-drains into the main drain itself. I have repeatedly had drains cut and allowed to remain open for several days, and have always noticed (where there were no springs or sand-veins) that although a small quantity of water enters the drain at the sides when first cut, this operation of the drain soon ceases, and the whole of the water enters on a level with the bottom, which is in accordance with the principles of hydrostatics. The water first descends perpendicularly by the fissures, worm-bores, &c., until they are filled above the level of the conduit of the drain, then takes a horizontal direction (*by percolating sideways through the perpendicular fissures*)* to the conduit of the drain, which it enters at the bottom;† and no clay land can be thoroughly drained where this is not the case, for if the water does not enter into every part of the land, and percolate by the fissures, &c., to the drains, but runs on the surface, or between the tilth and the floor upon which it rests, to the furrow over the drain, to filter into it *through the filling-in*, whatever plan may be adopted to facilitate the infiltration of the water to the drains, it will fail. From extensive experiments which I have made in filtering water, I have found that, through almost any medium, it is less difficult to clear 20 gallons of water holding siliceous or earthy matter (free from clay) in suspension, than one gallon of water with pure clay held in suspension. From the results of these experiments, on examining imperfectly drained clay lands, where the water stood

* The fissures in tenacious clay subsoil run perpendicularly from the surface, and are connected, as may be seen, on the surface, in dry weather, in every variety of form, but never run in a horizontal direction unless there is some admixture of other soil, or the bed of clay is very thin, so that a fissure runs horizontally between the clay and the floor upon which it rests.

† An important point to be determined in the drainage of land is, in which way does the water enter the conduit of the drain, whether through the *filling-in* or through the land; if through the *filling-in*, it enters at the top of the conduit, if through the land, at the bottom. In numerous experiments and observations which I have made, I have always found the water enters the conduit on a level with the bottom; and when I have directed the attention of experienced drainers to the subject, and after they have made their observations, I have found in *every instance* that the result of their observations was in accordance with my own, that upon well-drained land the water percolates through the land and enters the conduit on a level with the floor.

in the furrow over the drain, I found that the infiltration of the water into the drains was not impeded by what the drain was filled with immediately above the tiles, or other material of which the conduit was formed, but by the deposit of mud on the bottom and sides of the furrow carried there by the water running over the surface of the land, and from the bottom of the furrow at a higher level than where the water lay. The truth of this I proved by the following means:—After the water had remained till it was clear, and not higher than the floor upon which the tilth lay, I have had the water taken out, and carefully removing only 3 or 4 inches of earth from the bottom of the furrow, watching that the spade should not smooth the floor, nor the operator set his feet upon it, poured the water back again, when it has disappeared in two or three hours. I have also, under the same circumstances, cut a channel 1 foot, sometimes 2 feet, from the furrow (where the drain was immediately under it), parallel to the furrow of the same depth and surface, and then allowing the water to pass slowly into it, in two or three hours the water has disappeared which would otherwise have lain for days. I have in some instances, even where water was lying on the surface, found at a foot deep the common earth-worm at work, which also proves that the water was prevented by the sediment deposited on the bottom of the furrow from entering the land, as the worm cannot live in water. These experiments prove that the drainage of tenacious clay soils cannot be perfect if the water has to enter the drain from the surface, or through *the filling-in* immediately over it—for at whatever depth the drain may be laid, or the materials used *to fill in* above the conduit, there must be, for the acts of cultivation, 8 or 10 inches of soil of the same nature as that of the field, and if that be of a tenacious nature, the drainage will be imperfect, from the facts before stated.

The truth of these observations is exemplified in the drainage of pasture land—if two fields, one pasture, the other arable, are drained shallow, and in every way the same; if the land be undulating, the water, after a continuation of wet weather, will lie to a much greater extent upon the flat parts of the arable field than upon the pasture land; although the surface of the arable land may have been recently moved by the plough; the reason for which is that the water, in running over the surface and furrows of the grass land, does not become thick and turbid as upon the arable, consequently there is not the deposit to prevent that part of the water which is not carried to the drains by infiltration through the fissures, from filtering through *the filling-in* above the conduit.

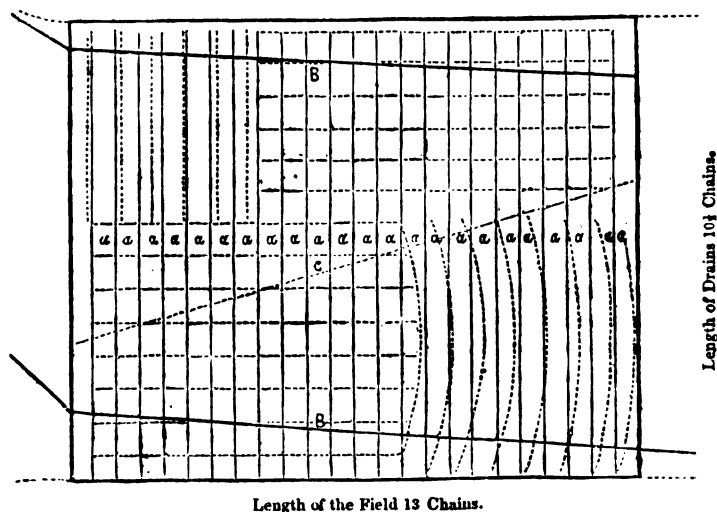
In land drained by open drains, very much the same effect is produced according to their depth as by under-drains; thus *with*

shallow open drains or furrows, tenacious clay soils will lie wet, but with deep open drains they will lie dry; in the one instance the water passes over the surface of the land to the drain, in the other through the fissures, worm-bores, &c. to the drain, which clearly demonstrates the advantage of deep drains, and that the water should percolate through the fissures, &c. of the subsoil to the drain, instead of over the surface, as is the case with shallow drains. I have in the winter season observed fields of grass and arable land, with shallow open drains or furrows, that if there were a deep ditch on any one side of the field, in which the water did not flow within 3 feet of the surface, the land for 4 or 5 yards from the ditch would be very dry compared with the lands in the middle of the field; but if the generally conceived opinion is correct, the whole field would be in the same state of dryness, whether the drains which carry off the water are 3 feet or only 6 inches below the level of the land, provided the water does not lie upon it.

If the injurious effects of water passing over the surface to the drains are admitted, and it must be by all who have paid attention to the subject, to thoroughly drain clay land, this evil must be avoided. I propose, from the experience and observations I have made on land drained by myself and others, to state the mode by which so desirable an object can be obtained under general circumstances, on tenacious clay-land, comparatively level or slightly undulating.

Fig. 1.

A Plan of Parallel Draining.



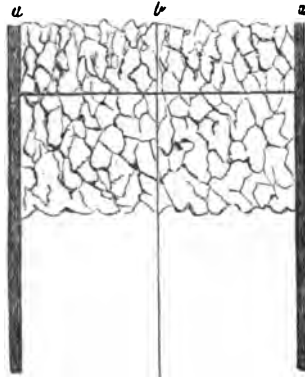
The above is a plan of the drainage of 13½ acres of land. The lines *a a* . . . show the parallel drains. The field is a piece of table-land, with but little fall into the ditches surrounding it, the highest part being, as shown by the dotted line *c*; the main-drains *B B*, to obtain a greater fall, are carried through the fields adjoining (to which in their course they act also as main-drains); the other dotted lines show the old ridges, or the four different directions in which the field was always ploughed previous to being drained. Where the parallel drains empty into a main it is unnecessary to lay them through the headland.

The ground being laid out as shown in Fig. 1, the space between the minor drains will be 21 feet; depth from 28 to 36 inches; the main and sub-main drains must be laid so that the bottom of the minor drains are on a level with the top of them. Where the old lands of a field lie in a proper direction for the fall of the main and minor drains, and their width is not less than 18 nor more than 24 feet, it may, to save expense of labour, be considered desirable to place the minor drains in the furrows, but for no other object. The operation of deep parallel under-drains, in conjunction with the atmosphere enlarging the fissures of the subsoil, is the most effectual in producing the free infiltration of the water, and laying the land dry; as the bed of clay will contract near the drains as deep as the drains are laid; and if they were laid a greater depth than is stated, the water would enter just as freely; for though all the operations in agriculture should be conducted with relation to a judicious expenditure, it is better to err in laying the drains deeper than is necessary than too shallow, for where water lies in the fissures and worm-bores below the level of the conduit of the drain, it rises by capillary attraction, and expands the subsoil, which partially closing the fissures, worm-bores, &c., prevents in heavy falls of rain the rapid infiltration of the water, thus causing it to flow over the surface to the furrows and flat parts, there to filter slowly through the deposit of mud on the surface, before it enters the fissures, &c., to percolate to the drain.

Some persons question if injury arises from water, not drawn off below shallow drains, rising by capillary attraction and expanding the subsoil; and also if such an agent exists:—a little reflection, and inquiry how it is that water poured into the pan of a common flower-pot so quickly ascends through the earth contained in it, will convince them that there is such an agent: and if they will take the trouble of filling two flower-pots with earth, and into the pan of one pour water, the earth will retain the same appearance, but in the other the earth will contract, leaving a cavity round it. To some extent the same effect is produced by water lying in the land below the conduits of shallow drains.

Upon land with a considerable slope, or if the clay subsoil contracts but little, 14 to 18 feet is not too near; but, as no general system can be laid down for draining clay land applicable to all localities, it must in many instances be determined by the Superintendent what depth of the drains, and space between them, will be sufficient to admit the free infiltration of water on land with a considerable slope. The course of the water to the drain on such lands is much longer than on level land, as shown by the Figs. 2, 3.

Fig. 2.



The drawing in Fig. 2 shows the fissures or cracks as they appear in dry weather on the surface of the land, *a a* the drain, *b* the ridge, and the black line from the ridge each way to the drains is intended to show that the water in its passage through the fissures or cracks (allowing for the zigzag course of the fissures) flows direct from the ridge to the drain on level land.

Fig. 3.

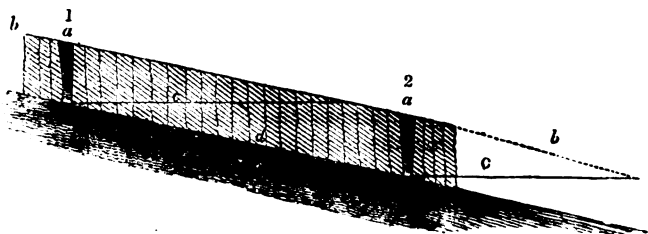


Fig. 3 shows the fissures, &c., on undulating land in the same manner as Fig. 2, *a a* the drains, *b* the ridge; the black lines are intended to show that the water has a much greater distance to flow or percolate through the fissures before it reaches the conduit of the drain than upon level land. The greater the declivity of the land the longer will be the distance for the water to percolate before it reaches the conduit: deep drains, by increasing the fall from the ridge to the conduit, in some measure counteract and shorten its course.

In Fig. 3 the water runs in an oblique, and consequently a longer course to the conduit of the drain than on level land, and if the drains are laid obliquely across the slope, as shown in Fig. 4, the water runs almost entirely in one direction to the conduit of the drain; whereas on level or comparatively level land it runs each way from the centre, as shown in Fig. 2.

On land with a considerable slope it is not only desirable to have a dry surface, but also to have as many drains as are necessary to admit rapidly the water into the land, to prevent it running over the surface and carrying the soil down the slope.

Fig. 4.



a a show the drains 30 inches deep, *b b* the slope, with a fall of 1 foot in 5; *c c* are horizontal lines; *d* is a line drawn parallel with the slope the supposed depth of the fissures; *e* the bed of clay below the fissures; the fissures are shown, as they run in clay land, by perpendicular lines: there are *very few* which run either horizontal or parallel with the surface. If the water flows over the surface, or through the fissures to the conduit, it is evident that almost all the water which falls between the drains *a a* will flow from the drain marked 1 to the drain marked 2, showing the necessity of the drains being nearer than on level or comparatively level land, where the water, as shown in Fig. 2, flows equally from the ridge to the drain on each side.

3rd. *Fall required, and the necessity of levelling high-ridged lands.*

A fall less than that generally considered necessary is sufficient for under-drains to carry off water. One yard for every 220 is

ample. Water will flow in large rivers with a fall of 3 inches in a mile, so that one yard in 220 is a fall 96 times greater than what water will flow at, which must be sufficient to allow for the friction of under-drains. I have stated the difficulty of water in heavy rains running from high-ridged lands and hills (holding clay in suspension) into the furrows and flat parts, filtering through the deposit of mud on the surface. Attention should be directed to prevent as much as possible the water running over the surface, to effect which the land should lie comparatively level between the drains, little or no more rise between the furrows than is produced by setting the ridge and ploughing to it.

As before stated, the furrows (except where the lands are of a proper width) are not to be taken as the course of the drains; and if they are high-ridged lands, the levelling of them, so necessary to perfect drainage, must be considered. I am aware of the objections to levelling clay-soils urged by many, that the land will not drain so well, that the ridges of the lands by the surface-soil being removed will produce but little corn, and the heavy expense, if the spade and plough are combined so as to spread the surface-soil regularly over the land. To the first objection, my experience proves that level land will drain better than high-ridged land, as the water has less tendency in heavy rains to flow over the surface, consequently there is less deposit of mud in the furrows and flat parts of the land, to prevent the infiltration of the water. To the second objection, the subsoil (*not the surface-soil*) should be made use of to level with, for it is most desirable to have the surface of the land when level of a uniform character, which it will not be if the surface-soil is made use of for levelling, as is the case if the plough only is used. Whatever mode may be adopted, the principle should be not to make use of the surface-soil, but so much of the subsoil as is necessary. The season best adapted for levelling and draining land, regard being had to the employment of the labourers, is from October to May; and the mode which I recommend, where the lands do not rise more than from 7 to 12 inches, as shown in Fig. 5, is to plough two rounds on each ridge, and the same or three in the old furrows, to open them as wide as possible; with the spade dig the subsoil out of the ridges, and throw into the furrows, and proceed as shown by the plans, until by cross-ploughing the object intended is effected. Although on this plan there will be to some extent an admixture of surface and subsoil, and a larger quantity of manure will for once be necessary, the whole will be of a uniform character and deeper tilth—whereas, if the plough only is used on most lands, by baring the ridges of the surface-soil the injury is *very great*. The cost of this mode of levelling land for spade-labour will be from 12s. to 18s. per

acre. On lands upon which clover has been sown too often, or, as it is termed, *clover-sick*, the admixture of subsoil and a little extra manure will make the land again produce clover freely, which will compensate in some measure for the cost of levelling.

Fig. 5.



a a show the ridges opened 18 inches wide; and to the depth marked *1 1* by ploughing two bouts on each; *b b b* the old furrows, by ploughing three bouts in each; *c c* a line drawn horizontal on a level with the old furrows; *d d* are horizontal lines, showing the quantity of earth required to be moved from the ridges to the old furrows, and partly over the land, to produce a comparative level surface.

The whole field being laid out in this manner with a plough, break up the subsoil in the ridges marked *2 2*, which with a spade throw into the old furrows marked *3 3 3*; then with the plough throw back the furrows *4 4* into *2 2*; again break up the subsoil and throw over as before; and so proceed with *5 5*, &c., until by cross-ploughing the land will lie comparatively level. In the plan the ridges rise 1 foot, width 10 yards. To reduce the ridges so that they shall not lie more than 2 inches higher than the furrows, the quantity of subsoil to be moved is only 2 cubic yards or loads in a chain; and as there would be 22 chains in an acre, the quantity per acre is 44 cubic yards or loads, which for spade-labour, according to circumstances, would cost from 3*d.* to 5*d.* per load.

4th. *Materials in this county best for under-draining.*

The materials best for forming under-drains in this district are the common draining-tiles and soles; for the small drains the tiles are from 12 to 13 inches long, 3 inches wide, $3\frac{1}{2}$ inches high, arched top, and perpendicular sides, with a sole half an inch wider than the tile which rests upon it. The tiles and soles are not only the most easy to make a drain, but form the most permanent conduit for the water, and resist the ravages of rats, moles, &c. &c. Some few persons in this county, since the great reduction in the price of tiles (the cost of a thousand tiles and soles being only 30*s.*), are advocates for using wood or peat, acting under the fallacious idea that drains formed with such materials admit the water more freely than those formed with tiles. I admit this to be the effect in some instances; but it does not arise from the drain being formed with wood or peat, but because such drains are laid deeper than those with tiles, and

thus approximate nearer the true principle of draining clay-soils; for such persons, acting under the erroneous impression that the water enters the conduit through the *filling-in* or medium over it, and not, as is the case, at the bottom, will lay the materials as near the surface as the necessary acts of cultivation will allow, and tile-drains being less liable to injury when laid near the surface than wood and peat, accounts for the latter acting better, as long as the conduit is not impeded, than the shallow drains formed with tiles, and thus the effect which arises from the increased depth is attributed to the materials of which the drains are formed. I consider I have already stated sufficient to prove that the obstruction to the entry of the water into the conduit of the drain does not exist near it, where the drains are laid deep, but at the surface; and, if so, there cannot be a question but that the material which makes the most regular and permanent conduit must be the best. Where parties (tenants) have plenty of wood growing upon their farms (willows, black-thorn, or even white), if they have not security for the outlay of capital necessary to effect a thorough and permanent drainage, for temporary purposes the use of peat, wood, or any other material or mode which is done at little expense, may be advisable; but if such materials are used, it will always be to the advantage of the occupier to have the drains laid deep.

5th. *Filling-in, whether with tenacious or porous earth.*

In no part of draining is there greater ignorance shown than in *filling-in* the drain after the conduit is formed upon tenacious clay soils. The modes adopted are very numerous, many of which I am unacquainted with, but the system generally adopted is to fill the drain immediately over the conduit with sod or turf, refuse wood, straw, or the surface-soil. The use of a good tough sod 1 inch thick, laid immediately over the tile to prevent the entry into the conduit of sand or other light substances with which the drain above the same is filled, is in many instances beneficial; but, with this exception, I am most decidedly opposed to putting any of the materials named in preference to the clay immediately above the conduit.* I have shown that attention to levelling the surface and deep draining is the most effectual in laying land dry, and not the material used to *fill-in* above the conduit; but if the difficulty did lie immediately over the conduit,

* Stones are rarely to be obtained in the clay-land districts of the south and east of England. I have for an experiment in a few yards of drain put 2 inches of stones, and beaten them down with a rammer, which I consider would be a good substitute where soles are not to be readily obtained; and I hesitate not in saying that if 2 inches of stones were laid in the bottom of a drain on a tenacious clay subsoil, then a sole and tile, and upon the tiles 2 inches of stones, a greater quantity of water would pass through the lower than through the upper bed of stones.

and not at the surface, clay is a better material than mixed soil. Where drains are *filled-in* with mixed soil, injury is likely to accrue to the conduit by the soil running down and choking it, and particularly so if the conduit is formed with wood or straw, when it decays. If the mixed soil does not run into the conduit, but concretes, it will be more impervious to the entry of water than clay, as mixed soils contract much less than clay from the action of the atmosphere and operation of under-drains.

I have repeatedly observed in heavy rains (on land imperfectly drained) the water running to the lower end of the field, and overflowing the lands almost to the ridges; the *greater quantity will percolate rapidly through the tilth and fissures to the conduit of the drain*; but the smaller quantity, when it is reduced to the furrow, and has to filter through the deposit of mud and *filling-in*, will be days in disappearing, unless aided by drying winds or frost, which, by contracting the surface-soil, admits the water into the fissures of the subsoil. With drying winds part of the water is evaporated, but by frost it is the contraction of the soil only which facilitates its infiltration, so that water will disappear in one night which would otherwise lie for days.

In this county (Huntingdonshire) for the last sixty or seventy years furrow-draining has been practised; and for the last ten years I think to a greater extent than in any district in England. Before the reduced price of draining-tiles, a system of block-draining on very stiff soils was practised; a drain was cut from 20 to 30 inches deep, 2 to 3 inches wide at the bottom, in which a round or other shaped block 3 feet long, or two or three short blocks connected together, of the same length and of the diameter of the bottom of the drain, were used. The firmest clay thrown upon the block or blocks, and with a rammer beaten upon the same; the block or blocks were then drawn forward by a lever or small capstan 2 or 3 feet, and the operation repeated in this manner throughout the whole length of the drain. *The permanency and working of drains formed in this manner depended upon the drain being deep, and the pure clay being firmly beaten down upon the wooden block or blocks, and making the conduit apparently impervious to the admission of the water.*

When this work has been carried on during the winter, and the atmosphere could have very little influence in contracting the clay round the conduit, to re-open the fissures closed by the operation of the rammer in beating the clay on the block or blocks, still there was no complaint of the water not entering the conduit. In this mode of draining the water must enter on a level with the bottom, for if the work is well done it cannot percolate through the arch until by the atmosphere fissures are formed in it. Where land is drained by the mole-plough, the spear or mole

being by great force drawn through the subsoil, makes the clay round the conduit more dense, and also the sides of the opening, traversed by the coulter connecting the mole or spear to the plough. Persons without reflecting consider the water enters the conduit from the surface, by the opening traversed by the coulter; but I can assure them that a very small quantity of water enters in this manner, the greater part, as in block-draining, enters the conduit on a level with the bottom. Seven years back, in the month of March, I drained about 60 acres of land, upon which wheat, tares and seeds were growing: by attaching ten strong horses to a mole-plough, the horses did little or no injury either to the land or growing crops or seeds by trampling, which proves the land to have been so dry that there could have been no water to run from the surface into the conduit by the opening formed by the coulter; still the drains ran freely on the following day after they were made. The system of block-draining, like the mole-plough, can only be temporary and in a stiff subsoil, free from springs and sand-veins, for upon land where there are sand-veins, &c., their operation is not certain for a season; so that if drains formed by this mode work well for ten or fifteen years, it is certain that the subsoil is a pure clay; and if the water enters freely, the fallacy of filling drains with porous earth or other materials, as being necessary to infiltration of water, is evident on pure clay-soils of great thickness, where the fissures are formed perpendicularly.

I have, from the time the Agricultural Society of this county have given premiums for draining (which takes place in the month of March), been appointed one of the Judges. The competition has taken place in a grass-field which has not been ploughed for ages. There are about 5 or 6 inches of soil, lying upon a subsoil of pure clay. This year six prizes were awarded for turf or wedge-draining, and the same number for tile-draining. Previously to this year prizes were given for turf or wedge-draining only; for it was considered that if a man could cut and execute, in a workmanlike manner, a drain of this description, he would be competent to make a tile-drain in a proper manner.

The number of competitors has been upwards of twenty; but, notwithstanding the number of prizes, from the superior performance of the work, the Judges found it so difficult to award the prizes that it was necessary to lay down certain rules, to be strictly adhered to by the drainers, which were as follows:—

1. The wedge or turf drain to lie not less than 30 inches deep.
2. The tile-drain to lie not less than 28 inches deep.
3. That the wedge should have the same inclination as the drain.
4. That the sides of the drain shall have a uniform inclination from the top to the bottom.

5. That the drain shall be perfectly straight, with a regular fall from one end to the other.

6. That too much earth be not moved in cutting the drain, it being considered that no more earth should be moved than is necessary for the drainer to perform his work with facility.

7. That the whole of the earth be again put into the turf-drain, and in the tile-drain as nearly as possible.

8. That the time for making a drain 22 yards, complete in every respect, shall not exceed five hours.

The width at which the wedge or turf-drainers lay out their work at the surface varies from $6\frac{1}{2}$ to $8\frac{1}{2}$ inches, the tile-drainers from 8 to 9 inches. The men, with these widths at the surface, cut the two sides of the drain with the same inclination from the top to the bottom, and so straight and smooth that it is scarcely possible for the eye to detect the slightest variation; and the bottom of the wedge or turf-drains not more than one inch wide, with a uniform fall. The wedge is placed and trodden firmly down within 5 or 6 inches of the bottom, and the clay put immediately over it, so that the waste turf and soil are again laid on the surface.* I have always noticed that the water runs into the main drain before the work is completed; but as the pure clay is put upon the wedge, and beaten down more closely than before it was dug out, the water cannot, for a short time, pass through the clay above the wedge into the conduit, but, as I have before shown, horizontally with the bottom, or through the sides.

Having proved, from practical observation, that the perfect drainage of tenacious clay soils, by any mode of *filling-in* above the conduit, cannot be effectual, I shall further state why the water in land not drained, and where the expansion of the subsoil during the winter has taken place, filters so freely into the drain on a level with the bottom. Land which lies wet from surface-water during the winter, at the middle or end of March will, on the surface, by evaporation, generally be dry, but below the surface it will contain water. The fissures, &c., being almost closed by the expansion of the subsoil during the winter, the water, in descending from the surface, becomes perfectly clear; and clear water will filter through almost any medium, and through any clay subsoil, to the depth the same has been contracted by the atmosphere in dry seasons. Where fissures, worm-bores, &c., are once formed in a retentive clay soil, they cannot be altogether obstructed unless the soil were worked together by artificial means. Most parties are acquainted with the difficulty that is often

* If the spring is advanced, it is recommended not to bring the waste turf quite to the surface, but to cover it with about one inch of light or top soil. The turf will quickly grow through, and not perish, as it is apt to do when laid on the surface in dry weather.

experienced in preventing clear water that lies in the land from filtering through cellar-walls, the embankment of reservoirs, &c.; and yet many drainers have an opinion that water cannot filter through the earth to a drain if it lies two or three feet deep. I have always, in my experiments, found that clear water would pass through any porous medium; but that water holding clay in suspension would choke the most porous mediums, as the following experiments will prove:—I dug in the winter season, on a gravel soil, two trenches six feet long each; and, after smoothing the bottom and sides of the trenches, poured clear water into one, and water holding clay in suspension into the other. The trench into which the water holding clay in suspension was poured ceased almost to filter after the first day, but the clear water in the other trench always disappeared in about an hour. I also took two flower-pots, and filled them with light earth to within one inch of the top; one was filled with spring-water, the other with water holding clay in suspension. The spring-water always disappeared in about an hour; but in the first instance the water holding clay in suspension required six hours, and after repeating the same it soon almost ceased to filter. I then took a third flower-pot, and filled it in the same way as the others, except that I put in two small earth-worms; then filled it with water holding clay in suspension. The worms, if the pot was filled three or four times each day, were sure to let the water pass, although I was careful to stop, every time it was filled, the bores which they opened for it to descend. I have always found in these experiments, when infiltration ceased, that if about one-eighth of an inch of residuum or mud deposited by the turbid water was removed, infiltration was as rapid as ever.

I have mentioned these experiments to direct the attention of parties who have to drain clay soils to the importance of studying the principles which should guide them in their operations, so that the present wasteful expenditure of capital, in many instances, may give way to a system which, although in labour more expensive, will effect a great saving in material, and protect the occupier against the loss arising from shallow defective draining.

6th. *The practical mode of draining clay land lying wet from surface-water, in which is considered the laying out of the ground for the mains and small drains, &c.; with the cost of draining with tiles, wood, peat, turf or wedge, and block-draining.*

In laying down what I have found to be the best mode of draining tenacious clay-land, the expense is greater than tenants of uncertain tenure would generally consider themselves justified in incurring, and therefore with many the ordinary modes will be practised; but there cannot be a question that the drainage

which is the most permanent and effectual is best both for landlord and tenant, although the expense is greater.

On entering the field to be drained, to obtain anything like good drainage, it is necessary, in the first instance, to lay down a plan of operation. The course of the main drain or drains is first to be determined, and marked by drawing a furrow with a plough, or by a number of stakes, being careful that there is sufficient fall, and that the small drains have not to run more than from 8 to 10 chains; and in laying down the course of the small drains, if the lands are all of a regular and proper width, there is a slight saving of expense to take the course of the old furrows; but where this is not the case, or if the old lands vary in their width, the better plan is to commence on one side of the field, and, without reference to furrows or ridges, lay out the drains (fall permitting) parallel with each other, as shown in fig. 1, observing, where there are forest-trees, not to approach nearer than 15 feet with the drains. Having proceeded thus far, the ground in the intended course of the main and small drains should be opened by ploughing two or three rounds for each drain; then take up a mole-furrow, so that the depth will be 10 inches from the surface, and a width of 9 inches for the drainer at the bottom of the furrow. The whole field being ploughed in this manner, proceed to cut through the hills to obtain a uniform inclination or fall of all the drains. After which I recommend, where the land is undulating, that the drains should remain in this manner for a few days, to see by the rill of water down them if the fall is regular, before the further operation of cutting the drains to the intended depth is proceeded with.* Whether the drains are laid shallow or deep, opening the ground in the line of the drains, and cutting through the hills to obtain a regular and uniform fall, is of the first importance; for, if attention is not paid to this most necessary part of the operation in draining land, the water will stand in some parts of the drain 2 or 3 inches deep, while in other parts they are dry; and the water lying therein, rising by capillary attraction towards the surface, and expanding the subsoil, checks the free percolation of the water to the conduit. When men are sent into a field for the purpose of draining it, and proceed at once to cut the drains and lay in the materials, it is impossible on some lands, however careful they may be, that the drains can have a uniform

* A friend of mine who is a very experienced drainer, and very particular in obtaining a uniform and regular fall for his drains, adopts the following plan:—He makes a small dam near the upper end of the drain, and, if the weather is dry, pours three or four pails of water above the dam; then suddenly removing the same, the water flowing down shows if there is any defect in the level.

and regular fall; and where that is not the case the drainage will be imperfect. The materials may now be laid down near the side of the drains;* and the drainers are to commence cutting the main-drain, beginning at the lowest point, and to such a depth that the top of the conduit shall lie on a level with the floor of the smaller drains: so that in heavy falls of rain, or from other causes, if the main should be nearly full, the water does not flow back in the smaller drains. In performing this part of the work, care should be taken to cut the bottom of the drain no wider than the tile, and a little hollowed out at the bottom to receive the crown of it; and the sides so that when the upper tile is laid, it cannot move from its bearing on the lower tile. This may not be practicable where there are many sand-veins, &c.; but on the strong subsoils of this and surrounding counties, the drains can be cut to any required width. In no instance, on strong subsoils, should I recommend for main-drains a single tile laid upon a sole: first, because the saving of expense is comparatively trifling; and, secondly, because in all sewers or water-courses, the lodgment, or accumulation of sediment, is much greater on a flat wide floor than where the bottom is an inverted arch. After cutting as much of the main-drain as can safely be done without the sides falling in, the drainer or tile-layer is to commence at the lower end to lay in the tiles, first laying two tiles on the floor of the drain, and then one on the top, resting equally upon the bottom two, and so in this way to break the joinings throughout the whole length of drain; and, where circumstances will permit, I prefer that the whole length of the drain should have the tiles laid before it is filled in. If the minor drains are of great length, the tiles in the main, where they cross, should have a small piece cut off the crown of the arch (which should be done at the tile-works), to admit the water to discharge more freely into it. When the whole of the main-drain is laid, and seen to have a regular fall, it may be filled in, except where the minor drains cross it. With the minor drains commence where they cross the main, which having been opened with the plough 10 inches deep, two draws (one with a spade 10 inches, and one with the draining-tool 12 inches) will, with the work as previously directed to be done, make the drains from 32 to 36 inches deep; and if the men are careful to

* In laying down draining-tiles it is advisable to avoid unnecessarily exposing them to the action of wet and severe frost. I have seen white and red tiles well burnt, when struck together giving a fine metallic sound, and which would have lasted for ages in the bottom of a drain, break to pieces if they have been frozen by very severe frost, as they lay in shallow water in the bottom of the furrows; and the same, it is well known, will take place with many descriptions of earthenware of the best quality.

take the two draws a regular depth, the drains will have a uniform fall. The bottom of the drain should be cleaned with a flat hoe, and the width not to exceed that of the sole. The drainer is then to proceed by laying a sole on each side of the main-drain, level with the crown of it; then a tile across the main, resting upon the main and two soles; then walking backwards or forwards, he will lay a sole and a tile throughout the drain. After the tiles are laid, they should always be examined before they are filled in; and in *filling-in* the small drains (except a piece of tough sod be laid upon the tile), lay the clay regularly, and trample the same firmly down, and the surface-soil at the top. The attention of drainers being generally directed to the *filling-in* above the conduit, I wish to draw their notice to that which is of much more importance—the floor of the conduit. Tiles laid without soles upon a pure clay subsoil, when the clay contracts in dry seasons, settle down; and when the wet season returns, and the clay at the bottom of the conduit expands, the clay rises slightly on the inside and outside of the tiles, so that the edges of the tiles by this means, after a few years, become imbedded in the clay. It must therefore be evident that if the water passes through the *filling-in* upon the crown of the tile, the greater quantity would descend to the bottom (except what enters at the joinings of the tiles), there to enter the conduit: so that in either way, whether the water percolates through the fissures, &c., of the land, and enters horizontally with the floor of the conduit, or through the *filling-in*, it is of the utmost importance that attention should be directed to the way in which the floor of the conduit is formed.

At the opening or mouth of the main-drain, and of the minor drains if they enter at once the outfall, a grate should be placed in each, about 3 or 4 feet from the opening, as a protection against injury, by preventing the entry of vermin. The expense of these grates is trifling, as the drainer, with a piece of nail-rod-iron, &c., can make them in the shape here shown, and place them where two tiles meet.



For the practical mode of performing peat,* wood, turf or

* Peat is produced in great quantities from the fens in this neighbourhood. It was used at one time to a considerable extent for under-draining tenacious clay soils, under the supposition that its porous nature admitted the water more freely than tiles; but it is now rarely used even by parties who can cut their own (the cost and carriage, under such circumstances, being very trifling): they now generally use tiles, although the expense is much greater. This no doubt arises from peat-drains failing to produce the result anticipated. Land now in my own occupation, which was previously drained with peat or turf, is a failure; but I attribute it as much to the drains being too shallow as to other causes, for there

wedge, and block draining, the rules for laying out the course of the main and minor drains, as stated in tile-draining, are equally applicable; and if it were an advantage to drain deep with tiles, it is more so with peat, wood, &c., for such drains are more liable to injury from the necessary acts of cultivation, particularly on the headlands, or lines of road traversed by carts in carrying on manure, &c. The greater depth perishable materials are laid, the longer they will be decaying. The depredations of moles are not so great in deep as in shallow drains, as their food generally lies near the surface: so that in every respect, except a slight increased charge for labour, deep drains are best, by effecting a more perfect drainage, greater protection against vermin, and injury liable to arise from the necessary acts of cultivation.

In peat, wood, turf or wedge, and block draining, if the minor drains empty into a main drain it should be formed with tiles; and if the minor drains pass through a light soil, which is very often the case, particularly at the lower end of a field, such parts should be laid with tiles. The mains and lower ends of wood drains should have a good fall, or they may be liable to choke, there being generally a greater quantity of soil carried down in such drains, when first formed, than others, particularly if straw and light soil are made use of to fill-in with. With these observations, the work being proceeded with in the manner as before described in tile-draining (except a narrower tool being used to take the last draw from the bottom of wood, peat, and wedge or turf drains), the same rules apply.

The drains should always be examined before they are filled in, not only to see if they have a regular fall, but that the material of which they are formed is properly placed; and, where wood is used, to see that it is free from small brush and leaves, and that upon the wood the pure clay is trodden firmly down to form the arch; for no dependence whatever can be placed upon their durability if straw and light soil are made use of to fill-in with, for if the conduit does not choke the first or second season, it generally does when the straw or other light material decays.

Summary of the expense of draining an acre of land in this county, with parallel drains 21 feet asunder, with tiles, wood, peat, turf or wedge, and block draining. The length of parallel drains, deducting the headlands, will be upon an average 680 yards:—

cannot be a question that if the conduit of a drain formed by peat could be kept from choking or injury, the result would be the same as tile-draining.

Tile-Draining.

	£.	s.	d.	£.	s.	d.
680 yards of drain will take 2040 tiles, at 20s. per thousand	2	1	0			
Ditto ditto 2040 soles, at 10s. per thousand	1	0	6			
Tiles for the main, say	0	3	6			
Average expense of carriage of tiles and soles	0	15	0			
				4	0	0
Expense of laying out the ground by the plough, cutting the hills, and main-drain or drains	0	4	0			
Cutting 31 chains, or 680 yards of drain, 21 to 22 inches deep, laying the tiles, and filling-in, at 3s. 6d. per score of 5 chains	1	1	10			
				1	5	10
				5	5	10

Wood-Draining.

Tiles for the main	0	3	6			
Expense of labour, the same as for tiles	1	5	10			
Cost of wood and carriage	1	15	0			
				3	4	4

Peat.

Tiles for the main	0	3	6			
Expense of labour, the same as for tiles	1	5	10			
2600 turf, at 8s. per thousand	1	0	10			
Carriage	0	10	0			
				3	0	2

Turf or Wedge-Draining.

Tiles for the main	0	3	6			
Cutting 31 chains, at 1s. per chain, and cutting the main, 1s. 6d.	1	12	6			
				1	16	0

Block-Draining.

Tiles for the main	0	3	6			
Labour, the same as for wedge-draining	1	12	6			
				1	16	0

Godmanchester, August 10, 1843.

XXXII.—*On a Disease in Potatoes.* By Sir CHARLES LEMON,
Bart., M.P.

ABOUT two years ago, I was made acquainted with the fact that a disease in field-potatoes cultivated in this neighbourhood had manifested itself in a way which threatened to become important, and to inflict serious loss on the farmers unless its cause should be discovered, and some remedy or prevention devised. It was with a view of trying what could be done in this matter by inquiry and by experiment, that I took up the subject; more in the hope of inducing others to turn their attention to it, than from any consciousness that I possessed opportunities sufficient to enable me to arrive at a very safe conclusion derived from my own experience. And in fact I have obtained no satisfactory result; so that experiments are yet wanting to determine the cause of the unnatural growth which I am about to describe. The symptoms of the disease are as follows:—The sets appear to sprout as they ought, and as others which surround them in the same field have done; but they are stopped short before they reach the surface, and no leaves are formed. Large patches in the field are thus left bare; and when the ridges are dug up, it is found that these abortive sets have formed each a little button about two or three inches from the surface, and, as it were, gone to rest after the effort. The disease produced no very sensible effects on the crops till about four or five years ago; but I have been informed by a farmer of this neighbourhood that he recollects a few instances in which these little dwarfs, called by the country people “Bobbin-Joans,” were noticed as long ago as thirty years. In the neighbourhood of Penzance, a great potato country, the failure of crop from this cause has been more general and more destructive than in any part of the country; in some instances destroying one-third of the produce. This information I derive from a gentleman residing there, on whose accuracy I place great confidence. Without dwelling on the name, then, let us inquire as to the thing, “*unde derivatur* Bobbin-Joan.”

The form in which the question first presents itself is, whether the defect is owing to the soil or the seed? Whether, in fact, some principle necessary to the growth of perfect potatoes is either naturally wanting in the soil, or has been, by excessive culture, extracted? And, again, whether the potato may not have contracted some disease, or perhaps have exhausted that vitality which we know will last only a limited time after the creation of a new plant from blossom-seed, though its produce may be extended over an unlimited surface by the propagation of its offspring. And this latter supposition is that adopted by the gentle-

man to whom I have before alluded, who says that the potatoes in his neighbourhood "have degenerated,* are degenerating, and ought to be regenerated." I shall presently state reasons why I do not agree with him; but first let me give the history of some of his experiments. He first took some potato-sets from a field which was much infested with Bobbin-Joans, and planted them in new ground; in the crop which was produced, there were some, but not very many, of these abortions. He then planted sets of a fresh sort in the ground previously supposed to be infected, and the crop was entirely free from the deformity.

At my suggestion a farmer in this neighbourhood has made the same experiments; and though the result agreed with that obtained near Penzance only in this, that good sets produced perfect potatoes in ground which had previously produced Bobbin-Joans, I think it is enough to prove that the condition of the soil is not the true cause of the complaint.

The point in which the issue of the experiments made here differed from that arrived at near Penzance, relates to the reproduction of imperfect potatoes from diseased sets. Here none such appeared; but there was a good and healthy crop. Moreover I have planted in garden-ground the very Bobbin-Joans themselves, in which, if anywhere, the disease must have prevailed, and in due time I dug up an abundant return of potatoes, every one of which was sound and of full size. From the foregoing experiments it appears to be clear that the condition of the ground is not the sufficient cause of the effect, and there is also a reasonable presumption that disease or constitutional debility in the plant arising from the decrepitude of age, computed from the original sowing, does not explain the loss of energy in the plant which was so easily revived by renewed planting. Then, I think we must look about for other causes to account for the stunted growth described; and the mode of planting the sets suggests itself as the most natural. There is some analogy between the effects thus produced, and the habit which may frequently be observed in the growth of certain bulbous plants. The common autumnal colchicum, for instance, if planted too deep, will make a shoot which stops short of the surface, and then forms a bulb in the position most favourable for its growth in the ensuing year; and I have even seen cases, when the plant has been accidentally buried very deep, where three or four of these bulbs have been formed at nearly equal distances from each other; thus, as it were, making its journey to the surface by stages. Therefore planting too deep, I have no doubt, may in some cases be the cause of the production of Bobbin-Joans. The root may not have strength to

* Note by Dr. Lindley—"When potatoes degenerate, they produce tubers of bad quality, but not Bobbin-Joans."

reach the surface, and so transfers its substance to a more favourable position. But this is a very imperfect solution of the difficulty; for in a field where the culture has been equal, and apparently there has been no variation in the depth of the plants in different parts, Bobbin-Joans have occurred in one place, and been entirely wanting in every other. This same remark is applicable to the idea which suggested itself to me, that insufficiency of nourishment and the absence of light might account for the imperfect growth of the set, as described in the third volume of the Horticultural Society's Transactions, p. 48. It is there stated that potatoes covered with sand and placed in a cellar will produce small tubers, exactly resembling the Bobbin-Joans. The author thus explains the phenomenon:—"The potato, from the abundant nourishment which the tuber affords to the embryo plant, has an extraordinary disposition to vegetate; and it seems to be possible to place it in such a situation that the vegetating power, being prevented from exerting itself upwards, so as to form stem and leaves, should be employed in throwing out roots only, with their appendages."

But I do not see how this cause can exist in the open field, for what is to prevent the vegetating power from exerting itself upwards? and I believe we must look in another direction for the natural history of Bobbin-Joan. The following circumstances seem to point to that direction; and I submit them to the growers of potatoes as leading to a conjecture to be verified or contradicted by their experience.

From a heap of potatoes lately turned, some of which had shot out to a considerable length, two or three examples have been brought to me in which the shoot had been suddenly stopped by a small tuber. On cutting open the potato, I found that the centre part had entirely decayed away, and not more than half an inch remained of the substance next the rind. This, however, appeared to be perfectly sound, but I suspect was not so in reality.

Furthermore, on referring again to the farmer from whose field I first got the Bobbin-Joans, and who had suffered severely in his crop in the season before last, I learnt that the potatoes from which he had taken the sets which produced the defective crop had been drawn in very wet weather, and stowed away without being properly dried. They had remained in that state; and I have no doubt that incipient decay, *though unperceived when the potatoes were cut*, had produced some change in the substance unfavourable to the growth of the set. Heating by fermentation, or from any other cause, and perhaps frost, may produce the same sort of disorganisation; and I think it is not difficult to conceive that the starch of the potato being prematurely changed into gum or sugar, and dissipated before the young plant is in a condition

to absorb it, the set may be rendered unable to afford the nourishment requisite for healthy growth. What remains of the original substance may be simply transferred to the little tuber; as the substance of the cotyledons of a bean are transferred to the first leaves, before those leaves have begun to perform their functions, and attract from the atmosphere the proper nourishment for the infant shoot.

The reasoning which I have thus indulged in, I confess, is not conclusive; but it may point the way to some useful and practical conclusions; and I offer it in the hope that the subject may be taken up by a more experienced agriculturist. In my hands the result pretends to no more than to be conjectural; and my surmises are as follows:—

1. That a chemical change may occur in the internal substance of a potato *which the eye cannot discern*, but which may render it unfit to afford nourishment to a young plant in the first season of its growth.

2. That this incipient decomposition may be produced by dampness, by heating, or by bruises.

3. That the utmost care is requisite to preserve that portion of a crop which it is intended to plant again, in the most perfect state of health and integrity; without trusting too much to the appearance of the potatoes which are cut for sets.

Carclew, April 18th, 1843.

P.S. Since writing the above, a circumstance has been related to me which at first appeared to be entirely inexplicable; but, on reconsideration, I think it is not at variance with my conjecture. A large quantity of potatoes were cut for seed: some of these were planted in the morning, and some in the evening of the same day. Those which were planted in the morning grew well; those planted in the evening produced dwarfs, and ended in a failing crop.

Now I think we have only to suppose that *incipient* fermentation had taken place in the heap of cut potatoes, and the result may be thus explained:—The sets which were at the top of the heap were sown first, and these would be less affected by the exclusion of air and the pressure of the heap. Those sown in the evening were at the bottom of the heap, and may have been bruised by the weight of the mass above them. At all events, fermentation would commence there, and therefore the chemical change of substance which would end in fermentation would commence there also.

A potato has lately been brought to me having a young one, apparently formed in the interior of the old potato, and now partly protruding through its skin. The old potato is only now beginning to grow at the eyes, in the ordinary way, but quite out of the ordinary season.

In this case the decomposition and reformation of substance seems to have taken place within the body of the potato. External circumstances of soil or air could not have caused the effect, because the potato had no roots or shoots capable of being acted upon by the atmosphere. So far the case seems to favour the opinion, that the growth of Bobbin-Joans depends upon the internal, probably chemical, condition of the parent set, and on no other cause.

I find that this disease is well known in Ireland, and I have heard it attributed to the *east wind*.

Carclaw, October 23rd.

XXXIII.—*Crown Estate at King William's Town, in the Counties of Cork and Kerry.* By J. FRENCH BURKE.

THREE years ago, some Parliamentary Reports respecting experimental improvements on the crown estate of King William's Town, in the counties of Cork and Kerry, were forwarded to this Society by the Commissioners of Her Majesty's Woods and Forests; and a summary of their contents was drawn up, which is published in the first volume of this Journal.

In December, 1841, two further Reports were made on the subject, and transmitted on the part of the Commissioners to the Duke of Richmond—as being then President of the Society—accompanied by a letter, of which the following is an extract:—

“ In the course of the experimental improvements now in progress on the crown's estate at King William's Town, in the counties of Cork and Kerry, in Ireland, a suggestion was made, in the year 1840, by your Grace to the then First Commissioner of this Board, as to the importance of a trial being made of the comparative value of Scotch and Irish cows, in respect to their relative produce in milk and butter; and the Commissioners accordingly directed the purchase of six Scotch heifers of the Galloway breed, in order to such an experiment being instituted at King William's Town, in regard to their produce as compared with a like number of Ayrshire and Kerry cows then on the estate.

“ The result of this trial, so far as circumstances would permit its being instituted, has been submitted in detail to the Board by Mr. Griffith, under whose superintendence the several operations on the

crown lands have been carried on, in his Report dated 13th of August last, detailing the proceedings of the previous two years."

From these Reports (as may be seen by their summary) it appears that the milk of the Kerry cows was richer in cream than that of either the Ayrshire or the Galloways; but rather inferior to the former in point of quantity.

KING WILLIAM'S TOWN DAIRY.

EXPERIMENTS on Ayrshire, Galloway, and Kerry Cows, from the 18th day of April to the 17th day of June, 1841.

—	Total Number of Quarts milked.	Number of Quarts set for Butter.	Number of Quarts given to Calves.	Number of Quarts sold.	Number of Pounds of Butter produced from Milk set for Butter.	—
3 Galloway cows	1,134½	1,115½	17	2	117½	9½ quarts of milk produced 1 lb. of salt butter.
Average number of quarts milked from 3 Galloway cows from the time of calving till the present date, 6½ quarts per day each.						
4 Kerry cows	1,769	1,698	64	7	191	8½ quarts of milk produced 1 lb. of salt butter.
Average number of quarts milked from 4 Kerry cows from the time of calving till the present date, 7½ quarts per day each.						
9 Ayrshire cows	4,313½	3,086	1,802½	25	302	10½ quarts of milk produced 1 lb. of salt but- ter.
Average number of quarts milked from 9 Ayrshire cows from the time of calving till the present date, 9 quarts per day each.						
The above 9 Ayrshire cows, when milked the first summer in 1839, having then produced their first calf, and each three years old, gave in the month of July 67½ quarts per day, being an average number of 7½ quarts to each cow per day. The same Ayrshire cows being six years old at May, 1841, each having produced four calves, gave in the month of June, 1841, 93 quarts per day, average number 10½ quarts to each cow per day for the month of June, being an increase of 2½ quarts of milk to each cow per day for June. The above four Kerry cows had each produced their first calf and were four years old at May, 1841. The above three Galloway cows had each produced their first calf, and were three years old at May, 1841.						

This, from the press of other matter, remained overlooked, but was recalled to recollection by a 'Statement of the comparative quality of Milk from Alderney and Kerry (*Irish*) Cows, upon the farm of the Hon. Robert Clive, M.P., at Oakley Park,'—as published in the second volume of the Journal: which shows the Alderneys to have been superior both in quantity of milk and cream. It was, however, accompanied with a note by the writer of this, doubting the experiment to have been satisfactory, and calling for further trials of a more accurate kind; which it is to be hoped will be complied with, as it is very important to have duly ascertained the real value of a stock so well suited to the cottager and the occupier of poor land as that of the Kerry breed.

With regard to the improvements made on the estate from the period of the former reports up to this communication, it is only

necessary to observe generally—that they have been carried on assiduously, and so judiciously, “that 139 acres of nearly unprofitable mountain-land have been reclaimed, manured, and cultivated, and thereby raised in value from about 4*d.* to from 8*s.* to 9*s.* per acre; while twenty-six new farmhouses and cottages have been erected.”

In regard to the roads—which were formerly impassable for wheel-carriages—they are now so improved, that during the last two years to which the reports allude, 5100 barrels of limestone (equal in weight to about 1000 tons) have been drawn to the estate from the quarry at Carrindulkeen, for the use of the tenantry; of which 3540 were used as manure; and additional limekilns are in the course of erection, to afford every facility for the reclamation of the land: it is, therefore, reasonably expected that, within a few years, the value of the estate will be more than doubled.

It is also gratifying to learn, that the effect of this experiment has so favourably improved the habits of the peasantry in point of temperance and industry, as to hold out a striking example to the neighbouring country, and a powerful inducement to the holders of poor, unimproved soils to adopt similar measures.

XXXIV.—*Past and Present State of Agriculture in Ireland.*

By WILLIAM BLACKER.

HAVING been requested to draw up a statement descriptive of the past and present state of agriculture in Ireland, for the Journal of the Society, I proceed to do so in the best manner I am able, merely premising that to enter into all the details which the subject would admit of, would be evidently impossible in a short compass; and I shall therefore confine myself to such a general view of the matter as my limits will permit.

It would be both useless and uninteresting to the Society to lay before them an account of the agricultural state of Ireland at any very remote period. A very small portion of the country was then capable of cultivation, owing to the extensive forests and morasses which everywhere abounded; and the excitement of intestine wars and interminable feuds possessed greater attractions for its inhabitants than the peaceful labours of the field. It seems therefore unnecessary to look further back than the justly-celebrated Tour of Arthur Young for a suitable starting-point. At this period the supremacy of the law was pretty well established; and it appears evident from the details he enters into that the minds both of the English settlers and the natives were

beginning to be turned towards agricultural pursuits. To enter into any particular examination of the statements given by this writer would inevitably cause me to transgress the limits to which I propose to confine myself; it appears sufficient to say that with few exceptions the general practice was to exhaust the ground by a ruinous succession of corn crops after potatoes, and then leave it *nominally* in pasture, but in *reality* producing almost nothing, for such a number of years as were considered in some measure sufficient to restore it to fertility, when it again underwent the same treatment, and thus nearly three-fourths of the farm were left in an unprofitable state, whilst the remaining fourth was expected to pay the rent of the whole and provide for the wants of the family besides. All modern improvements, such as draining, house-feeding of stock, proper rotation of crops, turnips, mangel-wurzel, clover, and artificial grasses, early ploughing, and thoroughly cleaning the land, were either unknown or unattended to; in short, it may be truly said that a worse system of cultivation, either in principle or practice, can scarcely be imagined. The consequences attending such a state of things could not be otherwise than most disastrous. Although the country was not one-third peopled, the miserable inhabitants year after year were exposed to all the horrors of famine, followed too generally by disease; and even in favourable seasons they were most commonly under the necessity of importing food. Contrasting the then state of Ireland, as described by Young, with its altered condition in the present day, when it maintains three times the number of inhabitants, besides exporting more food than the whole of the island produced in those times; and comparing also the general state of its present population with what it was then, they being beyond all contradiction better fed, better clothed, and better housed now than was then the case; it seems impossible to deny that, as population increases, the condition of society improves, notwithstanding all that may be said to the contrary: and the truth of this not only appears on a comparison of the general state of the country now with what it was many years back, but it also appears by a comparison between the state of the east and west of the kingdom at this present moment. In the west and south-west the population is small, and exhibits every appearance of poverty and destitution; whereas in the east and north-east, where the population is great, they are *comparatively* in the enjoyment of all the comforts of life. One cannot help being struck with the positive contradiction which these simple facts give to all the assertions of those who argue that the misery to be met with in Ireland is brought on by *over* population. The misery is to be met with, generally speaking, where the population is thinnest; and the least of it is to be seen where

the population is greatest. The question may naturally here be asked—How can this be accounted for? The answer is plain. The misery is occasioned not by the excess of the population in proportion to the capabilities of the soil, but to the deficiency of employment.

There is no doctrine upon which political economists are more agreed than that all the wealth of the world results from the labour of man; and, if so, how is a country to be enriched by exporting the labourer? So far, therefore, from its being the interest of the country that Government should expend its revenues to encourage the export of the population, the rationale of the thing seems to point to a different course, and suggest that its funds should be employed and its energies exerted to find employment at home; and instead of cultivating the wastes of other countries, to cultivate the wastes of our own. But to return from this digression, into which I have been inadvertently led, to the subject in hand—the first public effort made to excite a spirit of agricultural improvement seems to have been the establishment of the Farming Society of Ireland, which gave rise to great expectations, and certainly was productive of some good in improving the breed of stock, particularly swine, but upon the whole proved a failure; and the agriculture of Ireland, such as Mr. Young has described it, such it has remained, with very little amendment, until within a few years of the present time. It is true that in the neighbourhood of towns the proximity of the market, the abundance of manure, and the greater extent of capital, has led to a greater outlay upon land, and a consequent improvement in its general condition and management, whilst the wants of an increasing population, and the high prices of agricultural produce during the war, have combined in the country districts to bring more land into cultivation, and the produce of the soil has been thereby greatly increased; but, nevertheless, little improvement has been made until lately in the mode of cultivation, however much the surface under the plough may have been extended: still the augmented produce from new land has been an addition to the riches of the country, and the additional employment from increased cultivation has ameliorated the condition of the labourer by creating a greater demand for his labour. Such was the state of things at the peace of 1815; soon after this the prices of all kinds of agricultural produce began to fall to such an extent that the farmers were obliged to pay their rents out of their capitals; and this being a source very easily exhausted, the landed proprietors were in a very short space of time obliged to lower their rents, but in general their own necessities obliged them to do this with a sparing hand, still clinging to the idea that the existing depressions would prove but temporary; contrary, however, to these

expectations, the depression becoming permanent, it appeared in the end that those who had in the first instance made a liberal abatement to their tenants, and thereby enabled them to preserve sufficient capital for the cultivation of the land, had acted the wisest part; nevertheless, in every case the reduction of rent bore no proportion to the reduced price of landed produce, and the greatest exertions of the tenant became necessary if he calculated on continuing to hold possession of his farm. The fall, therefore, in prices of agricultural produce, and the reluctance of tenants to give up their holdings when no better prospect appeared elsewhere, had the natural effect of turning the attention of the farmers to increase the produce of their farms as the only means of meeting the change of circumstances that had taken place. This, however, could only be accomplished by an improved system of agriculture; in regard to which, though a slight improvement had taken place along the north-east coast from its proximity to Scotland, and the constant intercourse of the inhabitants, yet in districts but little removed to the westward, and throughout all the rest of the kingdom, the most thorough ignorance prevailed, and the old exhausting system, as practised in the days of Arthur Young, was everywhere as much followed as it ever had been at the time of his *Agricultural Tours*.^{*} Many tenants, therefore, finding it impossible to pay their rents by such means as they had hitherto used, and not having

^{*} That this picture is not overcharged may be seen from the report of the Agriculturist of the Roscommon Union Farming Society, inserted by the 'Royal Agricultural Improvement Society of Ireland' in their report for the year 1842, p. 53, of which the following is an extract:—

"Roscommon Union Farming Society.—During the latter part of the year the Committee employed the Local Agriculturist in inspecting all those parts of the Union to which his duties had not called him before, and in reporting the general state of agriculture in the district, with reference chiefly to the peasantry and other small holders of land. His reports give a melancholy account of the ruinous system of tillage practised throughout the Union, which may well account for a great deal of the poverty everywhere visible. The rotation generally followed is,—first year, potatoes, either manured or the land burned,—second year, potatoes without manure, if the soil be fertile enough to produce them, and, if not, a crop of oats,—third year, oats,—fourth year, oats,—fifth year, oats,—and so on till the land can produce no more. It is then allowed to rest, that is, it is left wild, without seed of any sort, which is called pasture, and on which a cow is turned out, and expected to give milk. After a few years, when the land again becomes green, it is again broken up and subjected to the same treatment.

"A Scotch or English agriculturist would find it difficult to solve the problem, how land under such a system could pay rent; nor would he wonder that the unfortunate tiller is so often reduced to starvation.

"Your Committee also find from the report of the Agriculturist, that in many parts of the Union the system of joint-tenantry prevails; and where this is the case improvement is quite hopeless."

an idea of any other more advantageous, at once abandoned the attempt, and, embarking for America, sought to better their situation in a new country; others gave up large farms, and contented themselves with smaller ones more suited to their capital and the increased labour which improved cultivation required; whilst others who had been accustomed to a life of ease, and comparatively of little exertion during the war, and not wishing to change their habits in due time, were finally ruined; and, if they had not remaining what would enable them to emigrate with their families, fell to the rank of poor cotters or labourers, and were obliged by necessity to earn a scanty subsistence by such employment as they could obtain.

A period like this for the tenants could not be very prosperous for the landlords, and accordingly many, unable to live at home as they had been accustomed to do, owing to the reduction of their rentals, sought a cheaper residence on the Continent; others were obliged to sell part of their properties, in order to lessen the interest upon their incumbrances, whilst many were obliged to sell their entire estates, and were completely ruined.

About this time, when the state of agriculture attracted general attention, the report of a successful attempt to improve the cultivation of the small farmers on the estates of the Earl of Gosford and Colonel Close, in the county of Armagh, got into general circulation, and excited a good deal of public attention. The improvement alluded to was the introduction of what is known under the name of the Flemish System of Husbandry—a system which had been recommended by all agricultural writers, and the advantages of which were well known to every person of education who had studied the subject; but all endeavours to introduce the practice of it among the small farmers of Ireland had been hitherto found unavailing: the theory was indisputable, but to carry it into practice was the difficulty.

To overcome this the following means were adopted upon the estates above mentioned:—In the first instance a small pamphlet was given to each farmer, with an injunction to read and consider well the contents, and afterwards to give their opinions upon the recommendations it contained. All the reasonings in the pamphlet in question being clear and simple, and adapted to the capacities of those to whom it was addressed, and the defects and disadvantages of the existing mode of cultivation being forcibly exposed, it was impossible for the most ignorant or prejudiced to place themselves in opposition to the truth of what was stated, and the answer almost invariably returned was this, “that the plan recommended was without doubt a good plan for those who were rich and able to follow it; but as to them, it would not suit them at all.” And although it was quite evident that the greater their

poverty might be the greater need they had of some means to better their circumstances, it was found impossible to extract from them any other reply. As my readers may have some curiosity to form an opinion of their own upon the pamphlet here alluded to, I venture to make the following extract upon the subject of manure for their perusal :—

*Extract from an Essay on the Improvement to be made in the Cultivation of Small Farms, addressed to the Tenants on the Estates of the Earl of Gosford and Colonel Close, in the County of Armagh. By WILLIAM BLACKER, Esq.**

“The only way, in my mind, to accomplish this, is, by introducing such a system of agriculture as would bring the entire of the small farmers’ holdings into a productive state, in place of allowing nearly half their farms to remain nominally in grazing, but in reality producing nothing; and as this cannot be done without manure, and manure cannot be had without stock, the consideration naturally arises, How can the greatest quantity of stock be most economically maintained, and under what management can the largest quantity of manure be derived therefrom?

“Now, by referring to the experience of all good farmers, in all countries, and under all circumstances, it is ascertained beyond dispute that by the practice of sowing green crops, such as clover and rye-grass, winter and spring vetches, turnips, mangel-wurzel, &c., the same ground which in poor pasture would scarcely feed one cow in summer would, under the crops mentioned, feed three or perhaps four the whole year round, by keeping the cattle in the house, and bringing the food there to them; and the manure produced by one of these cows so fed and well bedded, with the straw saved by the supply of better food, would be more than equal to that produced by three cows pastured in summer and fed in winter upon dry straw or hay, and badly littered. Here then are two assertions well worthy your serious attention—first, that three cows may be provided with food in the house all the year from the same quantity of ground which will scarcely feed one under pasture for the summer; and secondly, that one cow so fed in the house will give as much manure as three fed in the field. I call these important assertions; for if they are really founded in fact, then any of you who may now be only able to keep one cow would, by changing his plan, be able to keep three, and each one of these producing as much manure as three fed in the way you have hitherto been accustomed to adopt, the result would be that you would have nine times as much manure by the new method as you have hitherto had by the old. Now, as I do not think there can be a single individual among you so blind as not to see at once the great advantage it would be to have such an immense addition to his manure-heap, it appears to me that the best thing I can do is, in the first instance, to endeavour to impress firmly upon your minds the conviction that this fact, so much entitled to your attention, and yet so little attended to, is in reality a truth that may be relied on, and

* Groombridge, Panyer-alley, Paternoster-row.

may be practically adopted without any fear of disappointment ; it is upon this foundation that the practicability of almost every improvement I mean to suggest in the cropping of your land must ultimately depend, and it is therefore indispensable to the success of any arguments I may offer, to place it before you in the clearest point of view, and remove from your minds every doubt whatever upon the subject. To draw the necessary proof, therefore, from what comes under your own observation, I may say, every day of your lives, and which must therefore have more weight with you than anything else I could say, I refer you with confidence to the exhausted miserable pasture upon which your cattle are now almost universally fed, 2 to 3 acres of which are often barely sufficient to keep one cow alive for the summer months, but by no means to afford her a sufficiency of food. Now, 1 acre of good clover and rye-grass, 1 rood of vetches, and 3 roods of turnips, making up in all 2 acres, which are now allotted for grazing one cow in summer, taking a stolen crop of rape after the vetches, will afford ample provision for three cows the year round—for you all know that an acre of good clover will house-feed three cows from the middle of May to the middle of October; and with the help of a rood of vetches you will be able to save half the first cutting for hay to use during the winter: then when the first frosts, about the middle of October, may have stripped the clover of its leaves, the early-sown rape, which ought to be put in, ridge by ridge, as the vetches are cut, and the land well manured (if the seed has been sown by the middle of July), will be ready to cut and feed the cattle until the turnips are ripe. Here then you have plainly provision secured until the middle of November; and we have to calculate what remains to feed the cattle until the middle of the May following—for this purpose there is a rood of turnips for each cow. Now, an acre of the white globe and yellow Aberdeen turnip ought to produce from 35 to 40 tons per acre; but supposing one-half to be of the Swedish kind, let us calculate only on 28 tons to the acre, which is not more than an average produce, even if they were all Swedish, and see what that calculation will yield per day for 190 days, which is rather more than six months. If an acre yields 28 tons, a rood will yield 7 tons, which being brought into pounds, will amount to 15,680 lbs.; and this divided by 190 days will leave 83 lbs. of turnips for each cow every day, which, with a small portion of the hay and straw you are possessed of, is a very sufficient allowance for a common-sized milch cow; and, over and above all this, you have the second growth of the rood of rape coming forward in March and April, which would feed all the three cows much longer than would be necessary to meet the coming clover crop, even in the latest season.

“ Here then the facts of the case are brought before you for your own decision; and I fearlessly appeal to yourselves. Is it true that 2 to 3 acres (I make my calculation on 2 only) are frequently allotted to graze one cow during summer? and again, is it true that an acre of clover and grass-seed, a rood of vetches, and 3 roods of turnips, with the stolen crop of rape after the vetches, will supply food for three cows the year round? I defy any one of you to reply to either of these questions in the negative. The straw of the farm in any case belongs

to the cattle; but in the latter case, where turnips are provided for food, it is chiefly used for bedding: and the additional quantity of grain which will be raised by means of the increased quantity of manured land will always keep pace with the increase of the stock, and provide the increased quantity of bedding required. I think, therefore, I am warranted in considering my first assertion proved, namely, that the ground generally allotted to feed one cow will in reality supply food for three; and have now only to offer some calculations as to the accumulations of manure, which I hope will be considered equally conclusive.

"During the summer months your cow, which is only in the house at milking-time, and perhaps not even then (for the practice is sometimes to milk her in the fields), can afford little or no addition to the manure-heap, being upon the grass both day and night; and even in winter and spring, whilst there is any open weather, they are always to be seen ranging over the fields in search of food: so that I think you cannot but admit, upon a calculation for the entire year round, the animal is not in the house more than eight hours out of the twenty-four, and it is only the manure made during this period which can be reckoned upon: therefore, upon this supposition (which I think is sufficiently correct to show the strength of my argument, if there is any truth in arithmetic), one cow fed, as I calculated on, in the house for the entire twenty-four hours will yield as much manure as three cows that are only kept in the house for eight hours (the quality of the food being supposed the same in both cases, and this would manifestly prove my assertion); namely, that one cow fed within would give as much manure as three fed without; and, therefore, when three can be kept in the one way, as I have already shown, for one kept in the other, it is as clear as three times three make nine that the result of the calculation will be just as I have stated: namely, that the farmer will obtain by the change of system nine times as much manure in the one case as he would have had in the other. Now, if after all that has been said, which seems to me at least quite convincing, any of you should be so astonished by the quantity of the manure thus proved to be gained, as still to have some misgivings on the subject, and be inclined to think that matters would not turn out so favourable in practice as I have shown in theory, I would wish any such person to consider one very material point, which I have not yet touched upon; for in the foregoing the argument is founded entirely on the time the animals are kept within: viz., it is stated that one cow kept within for twenty-four hours will give as much manure as three cows which are only kept in for eight hours (the food being assumed to be the same in both cases); but it is quite evident that if the cow kept within should be fed with turnips, and bedded with the straw which the others are fed upon, leaving them little or no bedding whatever, that the calculation must turn decidedly in favour of the animal which is well fed and bedded, both as regards the quantity and quality of the manure; so that it appears the estimate I have made is decidedly under the mark."

However convincing the arguments here used may appear to most people, entire reliance was not placed in their efficacy. An

agriculturist, brought from some of the best-farmed districts in Scotland, was appointed to call upon every tenant, after sufficient time had been allowed for the perusal of the pamphlet, in order to enforce the reasonings contained in it, and to remove the difficulties which might be found to stand in the way of practically following them, so as to leave no excuse for their neglect. If manure was wanting, the agriculturist had power to lend what was required; if clover and grass seed were too costly to be bought, they were likewise provided, and other things in like manner. The agriculturist also went round each farm, pointing out what was wrong in the system pursued, and showing what ought to be followed in order to procure the best return from the soil. He also instructed them in the proper mode of cultivating the crops he recommended; showed them the use of the hoe in thinning their turnips; explained to them that clover had previously failed from being sown where the land was exhausted, and proved the truth of his assertion by the admirable crops which were soon after obtained by sowing the seed with the first grain crop after the potatoes, according to his advice. Nor were his instructions confined to these particular subjects; the whole economy of the farm was gone through: the necessity for drainage, where wanted, was pointed out; the advantage of straight *mearings*; the waste of ground occasioned by useless ditches; the proper cleaning of the soil; the use of lime; the good effect of early ploughing; and an infinity of other details, which it is not necessary to enumerate. It may be easily imagined that the arguments of an intelligent man, who proved himself perfectly acquainted with his subject, and who could teach how to hold the plough, or handle the spade or the hoe, would have a much more powerful effect upon those who heard him than any exhortations from gentlemen, who might be charged perhaps with preaching what they had never practised, and might therefore be supposed to know little about: and, by degrees, the effect produced was in conformity with this expectation. In the first instance, those who were unable to pay their rents, and foresaw the certain loss of their farms, were naturally inclined to adopt any plan that offered a hope of their being continued in possession; and the landlord was as naturally disposed to give them another trial under the new order of things. By this means a certain number of converts were set to work upon a proper system, the good effects of which soon attracted the notice of those in their immediate neighbourhood, and induced them to think better of, and by degrees adopt, the plan recommended to them; whilst the attention of those at a distance, both landlords and tenants, was almost equally attracted by reading the accounts which such of these poor men as had gained the premiums offered by Lord Gosford for their encouragement gave of

the advantages they had derived, as published in the reports of the Market-Hill agricultural dinner, which soon attained an extraordinary circulation, from the interest taken by the public in the success of the experiment. But the attention of landed proprietors in Ireland was excited more than elsewhere; many came in person to examine into the truth of the reports they had heard—many others sent deputations of their tenants, hoping thereby to make a favourable impression on them, and ensure their more readily adopting the same course; and in a little time the efficacy of the plan being very generally admitted, one landlord after another adopted it: some entirely, by getting over agriculturists from Scotland, and following up the system in all its parts; others partially, by advancing lime and seeds, and giving premiums for green crops, &c.; and everywhere the advantages of alternate cropping and house-feeding were strongly insisted upon by the speakers at every farming society and agricultural meeting, and in almost every part of the country a general spirit of improvement was aroused.* Nor was this movement entirely unaccompanied by some corresponding influence even in England. In some of the Market-Hill dinner reports comparisons were made, in regard to the stock maintained and crops produced upon the farms of the premium-men upon the Gosford estate, and the same quantity of land in several farms which obtained the premiums for being best cultivated in the west of England; in all which the greater productiveness of the land, both as to stock and crop, by the practice of house-feeding, threw the advantage greatly in favour of the former.

The Agricultural Poor Law Commissioners, in their course through the north of Ireland, had been struck by the agricultural improvement in progress, and had thought it of sufficient importance to be specially alluded to in their report; and Mr. Binns, of Lancaster, one of the Commissioners, makes particular mention of it in his work on the 'Beauties and Miseries of Ireland,' and has ever stood forward in all agricultural meetings to recommend the practice he had seen at Gosford; and everywhere recommended the circulation of the pamphlet already alluded to. This, joined with a favourable review of it in the Highland Society's Quarterly Journal, and the strong testimony borne to the merits of the system by the late ever-to-be-lamented Lord Clements

* Notwithstanding the abuse heaped upon Irish landlords, I think I may safely assert that the landed proprietors of Ireland, as a body, will bear a comparison with those of any other part of the United Kingdom, in an anxious desire to better the condition of their tenants, and improve the cultivation of their estates. I do not here include *middlemen*, "whose own the sheep are not," and who have no permanent interest in the land or its occupiers.

(who had been himself among the first to adopt it) in his pamphlet upon the Poor Laws, naturally led to its being pretty generally read in England, as well as in Ireland: and some landed proprietors, in districts where agriculture is in a backward state, are adopting at present the plan it recommends with such success as will most probably procure them many imitators. But, to return to Ireland; I cannot pass over the singular instance of the Rev. William Eames, near Tyrrell's Pass, having had the influence with his parishioners to induce the farmers voluntarily to subscribe for the payment of an agriculturist for their own instruction: and, by making the loan-fund available for the loan of lime, seeds, money, and the new manures, the system was at once put into successful operation.*

A circumstance so creditable to the influence of the clergyman, and to the good disposition of the parishioners, well deserves to be mentioned, as a similar instance cannot, perhaps, be produced within the limits of the United Kingdom. But by much the most decided impetus which has been given to the spread of the system, and the general and systematic improvement of the kingdom, has been given by the Earl of Clancarty. This nobleman was the first to adopt the plan of engaging an agriculturist for the Poor Law Union in which his property was situated; becoming himself responsible for his entire salary, leaving it open to all the gentlemen composing the Agricultural Society of the Union to employ him, at a weekly salary, to go round their different estates and give instructions to their tenantry; his lordship taking him, when not so engaged, to instruct his own tenants: thus the wages of the agriculturist were paid by those who employed him, leaving all the subscriptions and donations made to the Society to be distributed in premiums to those who most distinguished themselves amongst the competitors. For the valuable example thus afforded to the rest of the kingdom the public are indebted to the untiring zeal and active exertions of his Lordship, whose judicious arrangements and conciliatory conduct secured the support of all parties,

* There can be no doubt that a loan-fund may be made productive of great good by rescuing the poor man from the extortion of the petty usurer when he is overtaken by any unforeseen calamity, and in many other ways, of which the case here stated may be said to be one of the most important; but, on the other hand, it is to be recollected that the Irish character is naturally sanguine: Paddy is prone to indulge too much in favourable anticipations of the future, and apt to rely upon them much more than he ought. He and his neighbour, therefore, join and go security for each other; and the failure of the hopes of either leaves his partner liable to pay for both, and both become paupers. I fear this is too common a case, and that evil vastly exceeds the good which results from these establishments, in which I am confirmed by the opinion of those who have the best means of judging.

and has given a splendid instance of the good which may be effected by a single individual, where high station and sound judgment are united with business-like habits and an inclination to promote the welfare of those around him.

That I may not appear to overrate the importance of the part which his Lordship has taken, I beg to give the following summary of the success of the Ballinasloe Union Society, to which I have alluded above, taken from the report of their agriculturist, upon the second meeting of the Society, held in less than two years from its commencement—it has been published in the ‘Second Annual Report of the Royal Irish Agricultural Improvement Society,’ p. 51:—

“*Report of the Judges appointed to View the Crops of Turnips and Drill Potatoes.*—In discharge of the duty assigned to us, we beg to state that we have inspected the crops of the several persons who have served notices of exhibition, as well in the class of farmers for whose improvement your Society was established, as in the class of competitors for the Royal Agricultural Society’s Premiums. The increase in the number of competitors is so great that it would too much occupy your time to enumerate them. Last year there were but 13, while this year we found above 500 growers of turnips alone. The general improvement in cultivation is as remarkable as the increase of competitors; and, with a very few exceptions, is such as could only have been looked for in a country long accustomed to their growth.

“*Agriculturist’s Report.*—In addition to the book which I recently had the honour of laying before you, exhibiting what each farmer, acting under my instructions, has done, in proportion to the extent of his farm, I have now the honour, at your desire, to submit the following condensed Report:—

“*Number of Farmers who have sown different Green Crops this Year, viz.:—*

	Turnips.	Mangold- wurzel.	Vetches.	Rape.	Clover and Grass.	Total.
On the Right Hon. Earl Clancarty’s Estates	302	10	196	107	131	746
On D. H. Kelly’s, Esq., Castle Kelly	25	—	17	—	18	60
On Kelly’s Grove Estate, under T. H. Graydon, Esq.	13	1	3	1	2	20
On the Right Hon. Lord Ashtown’s Galway Estate	83	2	28	10	11	134
On Captain St. George’s Estate, under T. H. Graydon, Esq.	76	—	68	26	15	185
On Miss Donelan’s Estate, under Thomas Birmingham, Esq.	5	—	3	12	8	28
Total	504	13	315	156	185	1173*

* The report for the present year (1843) shows an increase in the total number to above 1730, who have changed their mode of cultivation under the instructions of the agriculturist, besides many others following their example.

Quantity of Ground under different Green Crops.

	Acres.	Roods.	Perches.
Under turnips	112	2	30
Under mangold-wurzel	2	1	24
Under rape	150	2	32
Under vetches	46	2	8
Under clover and grasses	216	2	24
Total	528	3	38

Number of competitors for turnips 170
 Quantity of drains executed 7,481 perches.

“ The improvements in draining, and extensive introduction of green crops, could not possibly have been effected in the absence of the landlord’s co-operation. In every part of the Union where green cropping has commenced, the farmers have got the loan of all the seeds, and have also received great assistance in draining. I am happy to say that there is a great increase of food for both man and beast amongst all the farmers who have commenced green cropping, upon a scale in every way commensurate with the extent of their holding. The increase (and nutritional qualities) of manure, by the consumption of turnips and other green crops during the winter and spring, will be very great; and that ruinous system of having cattle roaming at large in quest of food during the winter (by which incalculable injury is done to the ground) will be greatly lessened, if not altogether abandoned: but, until now, there was no other alternative. The green crops of every description have given the highest satisfaction; and the weight and cultivation of very many of the turnip crops would bear a general comparison with either Berwickshire or East Lothian.

“ JAMES CLAPPERTON.

“ *Ballinasloe, September 29, 1842.*”

It was not to be doubted that results like the foregoing would attract the attention of other Unions, and accordingly we find that several have since adopted the same plan; and when it is considered that the entire kingdom being divided into poor-law unions, the establishment of an agriculturist and an agricultural society in each would bring agricultural instruction within the reach of the most remote extremities of the kingdom, one cannot contemplate without a mixture of astonishment and satisfaction the sudden change which would in such a case be produced; nor can one cease to lament that any impediment should exist to the plan being more extensively acted on; but I fear both men and money are wanting at present, and we must only look forward in hopes that time and circumstances may yet ere long become favourable for carrying out a system apparently so well suited to the agricultural improvements of the country.

In order to follow up this subject I have been obliged to pass over the periods of the introduction of the furrow-draining system advocated by Mr. Smith, of Deanston, and the rise and progress of the Royal Dublin Society and Royal Agricultural Improvement Society of Ireland, and the formation of the Society for the Improvement of the Growth of Flax. No sooner had Mr. Smith's plan been made known by the publication of his pamphlet, than the Earl of Gosford hastened to adopt the practice of the Scotch landlords, and offered to advance as far as 5*l.* per acre at 5 per cent. interest to such tenants on his estate as chose to make trial of Mr. Smith's recommendations; by which means the practice has been early introduced upon his Lordship's estate, and the attention of other landlords extensively drawn to the results through the Market-Hill reports. In the introduction of this improvement in agriculture and the use of the subsoil-plough, its accompaniment, none have taken a more active part than the Marquis of Downshire, ever ready to patronise what may benefit the country and promote the introduction of everything practically useful. The introduction of this simple and effectual mode of draining may well be considered to make an era in the history of agriculture: the effect likely to be produced by it in Ireland, by increasing the produce of the soil, can scarcely be justly estimated; and its universal spread is only retarded by the want of capital to carry it everywhere into practice. Amongst the institutions for promoting the agriculture of the kingdom, the Royal Dublin Society and the Royal Agricultural Improvement Society hold the principal place; but their energies are cramped by the want of means to enter more decidedly upon the improvement of the mode of culture practised by the occupiers of the soil: and whilst I fully admit the high importance which belongs to each in being the means of keeping alive the interest of the Irish nobility and gentry in the improvement of every kind of stock, yet there is no denying that the process of feeding for these exhibitions would be ruinous to the farmer to adopt, and that the great object of benefiting the masses can only be effected by bringing their principal efforts to bear upon the better cultivation of the soil; and for this purpose it would seem by the result the system in operation at Ballinasloe is superior to any other of a public nature that has ever yet been tried.

The Flax Improvement Society cannot be passed over without notice, from the great importance of the crop to the improvement of which its efforts have been directed. Before the introduction of flax-spinning mills the importation of foreign flax was entirely unknown; the hand-spinners formed the only market: and these being scattered over the face of the entire country, no

wholesale market could be obtained by the importer ; but as soon as the spinning-mills at Dundee and Leeds were established, an entire revolution in the trade took place—the hand-spinner was undersold and driven out of the market ; and the wholesale demand of the mills giving encouragement to importers, the supply was obtained from Russia at pretty much the same cost of transport as from the north of Ireland country markets, at a cheaper rate and of a more even quality. The Irish grower, therefore, being unable to cope with the Russian importations to the east coast of England, and having lost the home market by the ruin of the hand-spinner, was obliged to give up the crop and turn his land to something else : but upon the establishment of flax-spinning mills in Belfast the Irish farmer had less way to go to market with the article, and his foreign competitor had a farther distance to come, from which he (the Irish grower) derived a certain advantage ; and the crop has again been cultivated to a great extent : still, however, the low price at which Russian flax can be imported makes the crop but little remunerative, except where fine qualities are produced, in the growth of which our only competitors are the natives of Holland and Belgium. From the laudable desire to teach the Irish farmer to improve the quantity and fineness of his crop, the Flax Improvement Society originated, and certainly has done service in turning the attention of the farmers to a more careful management of the article ; but it cannot be said to have almost in any degree established the Flemish practice : nothing will overcome the general opinion of his own skill which the Irish farmer entertains, but the undeniable fact brought before his eyes of a Belgian buying one-half his field of flax and treating it in the Flemish way, leaving him the other half to be treated according to his own, and then taking the two parcels into the same market ; when, if the Flemish method produces a superior price after paying for all expenses, the question is decided ; and without this proof, however the Irish farmer may be induced to pay a little more attention in some things, yet the adoption of the Flemish system will be slowly, if ever, established. Although this plan has not been directly followed by the Flax Improvement Society, it has been reported that through the encouragement it has afforded, a dealer in flax has come over from Belgium with sufficient capital to be employed in purchasing the growing crops of flax in this country for the purpose of making a profit by the superior quality and fineness the article will acquire under his mode of treatment ; this would at once put to the proof whether the flax in Ireland can be brought to rival the growth of Holland and Belgium : if so, the farmers will not be slow to adopt the new method ; and an advantage will be conferred on the king-

dom of the very greatest importance, and for which the entire merit will be due to the Flax Improvement Society.*

Having brought down the history of these societies to the present time, I cannot better conclude this imperfect account of the state of agriculture in this kingdom, than by expressing my fervent hopes that such exertions may be made both by landlord and tenant to increase the produce of the soil, and at the same time lower the cost of production, that they may be able mutually to escape the difficulties which now seem to be impending over them.† The general introduction of guano and bone-dust, which bids fair to take place at no distant period, by making up for the lamentable deficiency of farmyard manure which at present prevails, seems to me to offer the only solid foundation on which to rest any favourable expectations; Lord Gosford and Colonel Close have imported largely for the use of their tenants, and no doubt many other landlords either have adopted, or soon will adopt the same practice, so as, if possible, to get the turnip-crop cultivated by supplying manure without the necessity of subtracting from that required for the cultivation of potatoes, which has always been the great bar to its introduction. One thing seems certain, that unless this result is accomplished by means of these new manures, or that they themselves become a sufficient substitute for the manure arising from that crop, there can be no rational expectation entertained that the required increase of produce can be obtained to meet the difficulties of the present times.

WM. BLACKER.

* Two gentlemen acquainted with the Belgian mode of treating the flax crop have settled in the north of Ireland, and are supposed to be carrying on a good business in flax-dressing; but, as their object is individual profit, they cannot be expected to bring their practice to the above-mentioned test, which would eventually destroy their own trade.

† When I refer to increased produce as a remedy for present low prices, I do not mean to assert that it will be sufficient to compensate the farmer if carried to an unlimited extent. It is only true as long as the increase of crop is in proportion to the fall in price; but if from an over supply annually increasing the fall in price exceeds that proportion, the farmer can no longer be indemnified thereby, and this is sure to take place whenever the produce exceeds for any length of time the consumption.

XXXV.—*Report on the Exhibition of Implements at the Derby Meeting in 1843.*

WITH a few preliminary remarks the Judges proceed to lay before the Council their award of premiums, and an analysis of the implements exhibited at Derby.

They have already stated, at the desire of the Council, the motives which induced them to withhold particular prizes offered by the Society; advising, for certain specified implements, a more lengthened and accurate trial than circumstances permitted at the Meeting. The adoption of this advice by the Council, together with the new and improved rules already made known, or under consideration, for the management of trials at future shows, spares the necessity of alluding further to the reasons which induced the Judges so to act; borne out, too, as they were, by a previous resolution of the Council to that effect.

The Judges have again the gratification of recording that, in number, variety, and perfection, this exhibition greatly excelled all that preceded it; and their thanks are due to the Council for sanctioning their application of the pecuniary value of the withheld prizes to the rewarding of many useful and unexpected implements, which were not, and could not be classed by the Society as special objects for encouragement. Justice to the exhibitors, and the fulfilment of the intent of the Society, required this appropriation of the funds set apart for the furtherance of agricultural mechanism; and, perhaps, a more substantive proof of the progress made in this great department of the Society's solicitude cannot be adduced, than that the exhibitors annually outgrow enlarged show-yards, and entreat more stringent and exact trials of their implements.

It is thought that the following analysis of the contents of the show-yard may not only serve to convey a just idea, but be a proper historical record, of the magnitude and variety of the collection; and that it may tend to confirm the Council in their desire to render the catalogue of implements a perfect register of the exhibition. As such, the catalogue would become not merely a momentary guide, but a useful annual work for native and foreign purchasers to consult, after as well as during the show. With the appendage of an analytical index, the agriculturist, on entering the yard, would at once be enabled to direct his attention to the more particular objects of his search, and the document would thus contribute equally to the advantage of exhibitors and the public. The analysis now given, as prefatory to the award of premiums, and usual short account of some of the implements, presents a concise classification of the machinery employed in various departments of British husbandry; and it may possibly

aid the Council in selecting the objects or classes which more particularly demand future encouragement by the Society. With this view, the number of prizes allotted to each class and object is also tabulated.

As a digest of the nature, number, and value of the implements in habitual use by farmers, it cannot fail to impress the mind with the importance of agricultural mechanism as a branch of national industry, and as consuming an immense amount of native materials. Nor will it, perhaps, be uninteresting to the agriculturist and his mechanic to learn that not a few highly skilled Lancashire manufacturers and mechanicians, attracted by proximity to the meeting, expressed unqualified admiration of the workmanship and constructive skill displayed, with no slight surprise that so many varied and necessary tools were used in the culture of the soil and preparation of animal and human food.

The award of premiums has been arranged on this occasion with a reference to the page of the published catalogue, the number of the exhibitor's stand, and that of the article rewarded. A reference to the article forming the subject of a prize has been deemed advisable, in order to define it; as, in many instances, an exhibitor produced a large variety of implements of the same class, having an apparently similar but really a distinctive character and application, each being adapted to some specific operation in the art of agriculture.

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ANALYSIS OF THE EXHIBITION.

ANALYSIS OF THE EXHIBITION.		No. of Articles.	No. of Exhibitors.	No. of Prizes.
Tillage Implements.				
PLOUGHS :—				
Swing, moulding and ridging, included	48	..	..
One-wheel	15	..	..
Two-wheel, double-furrow included	55	..	..
Subsoil, common	3	..	..
Ditto, various	6	..	..
Sub-pulverisers	4	..	2	
Ditto and surface-ploughs	3	..	1	
Ditto and hoes	2	..	..
Stubble and paring	4	..	1	
Water-furrow clearing, or boat-plough	1	..	1	
Draining	3	..	1	
Drill-ploughs, one-row	3	..	1	
Ditto, three-row	1	..	..
	148	41	7	
HARROWS :—				
Common, and improved	19	..	2	
Drag, and scarifying	2	..	1	
Extirpating	1	..	..
Lever	2	..	..
Revolving and sowing	1	..	..
Ditto, vertically	1	..	..
Ditto, horizontally	1	..	1	
Chain-web	3	..	1	
Folding	1	..	..
	31	24	5	
SCARIFIERS :—				
Cultivators, grubbers, scufflers, included	25	17	Two reserved for future trial.	
CLOD-CRUSHERS :—				
Various	7	7	..	
ROLLERS :—				
Various, cast and wrought iron	12	7	..	
COUCH-RAKES :—				
Various	4	4	1	

ANALYSIS OF THE EXHIBITION.		No. of Articles.	No. of Exhibitors.	No. of Prizes.
Drilling, Sowing, Manuring, and Hoeing Machines.				
DRILLS AND PRESSERS :—				
Drills for corn and seed, with manure . . .	14	..	4	
Ditto ditto, without manure . . .	1	..	..
Ditto for turnip-seed, with manure . . .	16	..	1	
Ditto ditto, without manure . . .	1	..	..
Ditto ditto, with manure-cart . . .	1	..	1	
Ditto for seeds, with manure . . .	3	..	1	
Ditto ditto, without manure . . .	10	..	1	
Ditto and Pressers, with manure . . .	6	..	1	
Ditto ditto, without manure . . .	4	..	..
Ditto for solid manures only . . .	1	..	..
Ditto for liquid manures only . . .	1	..	1	
Pressers, without drills . . .	2	..	..
Seed-sowing barrow, without manure . . .	1	..	..
Drill-ploughs—(see PLOUGHS.)				
	61	24	10	
DIBBLERS :—				
Five-row horse dibbling machine and sower . .	1	..	..
Two-row ditto ditto . . .	1	..	..
Two-row hand or horse dibbling wheel . . .	1	..	1	
One-row hand ditto . . .	1	..	..
	4	4	1	
HORSE-HOES :—				
Broad, narrow, and variously contrived, to suit drilled crops . . .	20	13	3	
Harvesting Machines.				
HAY-MAKING :—				
Tedding machines . . .	4	..	1	
HORSE-RAKES :—				
Hay, corn, and stubble . . .	7	..	..
	11	9	1	
Barn Machinery.				
HORSE-ENGINES :—				
Various powers, travelling and fixed . . .	7	5	..	

ANALYSIS OF THE EXHIBITION.		No. of Articles.	No. of Exhibitors.	No. of Prizes.
STEAM-ENGINES :—				
Travelling, for threshing, &c.		3	..	2
Applied to corn-mills, &c.		3	..	..
		6	2	2
THRESHING-MACHINES :—				
Driven by hand		4	..	..
Driven by horse or steam power		11	..	..
		15	6	..
WINNOWER, CORN-CLEANING, AND BARLEY- HUMMELLING :—				
Various		20	14	3
CRUSHING AND SPLITTING MILLS :—				
Various		36	10	2
CORN AND MEAL MILLS :—				
Metallic hand corn-mills		8	..	..
French burr ditto		3	..	..
Grey stone ditto		1	..	..
Mill, with two-horse power engine		1	..	..
Mills for animal, engine, or other power		4	..	..
Metallic meal-mills		2	..	..
Hand dressing-machine		1	..	..
		20	4	Two reserved for future trial.
CHAFF-CUTTERS :—				
Various, adapted to manual, animal, and steam power		51	22	2
CAKE-CRUSHERS :—				
Various		14	9	1
CORN WEIGHERS AND METERS :—				
Weigher		1	..	..
Meter, self-registering		1	..	1
		2	2	1

ANALYSIS OF THE EXHIBITION.		No. of Articles.	No. of Exhibitors.	No. of Prizes.
Field, Fold, and Yard Machinery.				
TURNIP-CUTTERS:—				
Hand and portable	11	..	1	
Attached to cart	1	..	..
	12	10	1	
ROOT-GRATING, AND SQUEEZING MACHINES:—				
Graters	2	..	..
Cider-mill, turnip and potato squeezer	1	..	1	
	3	3	1	
POTATO-WASHERS				
	2	2	..	
STEAMING APPARATUS:—				
Various	5	5	1	
FEEDING APPARATUS:—				
Consisting of iron pig-troughs, pens, cow and sheep cribs on wheels, mangers, racks, &c. .	..	3	1	
Fodder preserver . . . . .	..	1	..
	..	4	1	
WEIGHING MACHINES:—				
For carts, cattle, sheep, &c.	4	2	1	
FIRE-ENGINES, &c.:—				
Fire-engine, with irrigator, attached to steam- engine	1	..	..
Ditto, hand and portable	4	..	..
Garden-engines, various	6	..	..
	11	5	..	
STACK-YARD:—				
Proposed substitutes for thatch	5	..	1	
Rick ventilator	1	..	1	
Hay sample borer; assortments of rick-cloths, iron rick-stools, and frames, &c. . . . .	..	..	..
	..	9	2	

ANALYSIS OF THE EXHIBITION.	No. of Articles.	No. of Exhibitors.	No. of Prizes.
SUNDRIES:— Iron barrow for heating and transporting tar 1 .. 1 Machine for breaking stones 1 Fan blower, for out or in-door forge 1 Iron field-gates 3 .. 1 Assortments of iron hurdles, fencing, seats, barrows, trucks, &c. Saw-machines, screw-jacks, cranes, pumps, garden-tools, &c. Weed and bush extractor, assortment 1 12 3			
Agricultural Carriages, Harness, and Gear. WAGGONS, CARTS, &c.:— Waggon, without springs 7 ———, on springs 3 .. 1 Harvest waggon, on springs 1 Market and corn delivery carriage, on springs 1 .. 1 Waggon, formed of two combined carts 1 .. 1 Carts, without springs 10 ———, for general and harvest work, on springs 3 ———, for harvest, without springs 5 ———, market and family, on springs 2 ———, for liquid manure 3 ———, for solid manure, with drills 1 ———, with solid and liquid manure bodies 1 .. 1 38 15 4			
BREAKS:— Applicable to waggons, carts, and carriages of all kinds 1 1			
SETS OF WHEELS, AXLES, &c.:— Various 6 1			
HARNESS AND GEAR:— Set of single-horse Scotch harness Sets of improved hames, saddles, bits, and reins Whipple-trees, or coupling-bars 1 8 1			

ANALYSIS OF THE EXHIBITION.		No. of Articles.	No. of Exhibitors.	No. of Prizes.
Drain-Tiles and Implements.				
Machines for making tiles and bricks		2	..	2
Set of tools for forming concrete drains		1	..	..
Sets of specimens of tiles		3	..	2
Drainer's levels		2	..	1
Screen for sorting drain-stones		1	..	..
Draining-ploughs—(see PLOUGHS.)				
		9	8	5
Dairy Implements.				
CHURNS:—				
Upright, various motions		4	..	1
Box, ditto		4	..	..
		8	8	1
CHEESE PRESSES:—				
Single		4	..	1
Double		1	..	1
Single, with curd crusher attached		1	..	..
		6	6	2
CURD MILLS:—				
Various		3	..	..
Milk truck and cask		1	..	..
		4	4	..
Miscellaneous.				
Dynamometers, two kinds		4	..	Reserved for future trial.
Odometer, or land measurer		1	..	
Veterinary instruments, various . . . . .		..	..
Collections of soils and manures . . . . .		..	..
Map in relief for exhibiting the water-levels, undulations, and geology of a district		1	..	1
		..	6	1

ANALYSIS OF THE EXHIBITION.		No. of Articles.	No. of Exhibitors.	No. of Prizes.
Domestic.				
Cast-iron barrel thrawl, or tilter		1	..	1
Meat-salting machine		1	..	..
Egg-hatching ditto		1	..	..
Flour-mills, garden-engines, and tools — (see BARN MACHINERY.)				
		3	4	1

Aggregate value of the implements, according to the selling price declared by the makers, about £7400.

AWARD OF PREMIUMS.

AWARD OF PREMIUMS.	Prize.	Reference to Catalogue.		
		Page.	Stand.	Article.
1. PLOUGHS.				
To David Harkes, of Mere, near Knutsford, for his Draining Plough; his own invention . .	£10	18	14	1
To Hugh Carson, of Warminster, for his Subsoil-Pulverizer; his own invention	£10	61	49	1
To John Bruce, of Tiddington, near Stratford-on-Avon, for his Plough with Subsoil Apparatus; his own invention	£5	38	31	1
To the Earl of Ducie, of Tortworth, near Wootton-under-edge, for a Subsoil-Pulverizer; invented by the Hon. M. W. B. Nugent, with additions by John Morton of Chester Hill	Silver Medal.	6	5	8
To Edward Hill, of Brierley Hill Iron-Works, near Dudley, for an Iron Skim-Plough, for paring Stubbles; improved by J. A. Stokes, of Harvington, near Evesham	£3	22	16	9
To John Meakin, of Spondon, near Derby, for his Plough and Drill combined; his own invention	£2	40	36	1

AWARD OF PREMIUMS.	Prize.	Reference to Catalogue.		
		Page.	Stand.	Article.
To John Caborn, of Denton, near Grantham, for his Boat Plough, for clearing water-furrows; the invention of A. Stickney, of Ridgemont, Holderness	Silver Medal.	26	20	3
2. DRILLS.				
To Messrs. R. Garrett and Son, of Saxmundham, for their Drill for general purposes; their own invention	£30	41	39	1
To Richard Hornsby, of Spittlegate, near Grantham, for his Twelve-coulter Drill; his own invention	£10	34	26	2
To Richard Hornsby, of Spittlegate, near Grantham, for his Thirty-coulter small-seeds Drill; his own invention	Silver Medal.	35	26	4
To Richard Hornsby, of Spittlegate, near Grantham, for his Manure Cart with Drills attached, both for ridge and flat culture; his own invention	Silver Medal.	35	26	9
To Thomas Hunter, of Ulceby, near Barrow-on-Humber, for his Ridge-turnip and Manure Drill; the invention of Mr. Cartwright	£5	39	34	2
To James Smyth, of Peasehall, near Yoxford, for his Nine-coulter Corn Drill, particularly adapted for hilly land; his own invention	£5	74	65	3
To John Caborn, of Denton, near Grantham, for his Corn and Turnip Drill; his own invention	Silver Medal.	26	20	2
To William Crosskill, of Beverley, for his patent Grass-land Cultivator, with Seed and Manure Drills; his own invention	Silver Medal.	28	21	2
To Thomas Huckvale, of Over Norton, Oxon, for his Liquid Manure Drill; his own invention	£5	101	84	2
3. CHAFF CUTTERS.				
To the Earl of Ducie, of Tortworth, near Wootton-under-edge; for his patent Chaff Cutter, invented by himself, R. Clyburn, and E. Budding	£10	7	5	14
To James Smith, of Gloucester, for his Chaff Cutter; invented by himself	£3	48	40	1
4. DRAINING TILES.				
To the Tweeddale Patent Drain-Tile and Brick Company, London, for a Hand-Tile Machine; invented by the Marquis of Tweeddale	Silver Medal.	20	15	1

AWARD OF PREMIUMS.	Prize.	Reference to Catalogue.		
		Page.	Stand.	Article.
To Messrs. J. A. and R. Ransome, of Ipswich, for a Patent Tile and Brick Machine; the invention of R. Beart, with improvements by A. Stickney	Silver Medal.	80	66	26
To F. W. Etheredge, of the Woodlands, near Southampton, for his Drain Tiles with covers; his own invention	Silver Medal.	113	135	1
To J. Read, of London, 35, Regent Circus, for his Cylindric Drain-Tiles; his own invention	Silver Medal.	115	113	4
5. HARROWS.				
To John Howard, of Bedford, for a set of Patent Four-beam Iron Harrows; invented by W. Armstrong	£5	67	57	8
To Messrs. Sanders and Williams, of Bedford, for their Patent Iron Harrows	£5	105	89	15
To Robert Hopkin, of Hartington, near Ashbourne, for his Circular Horizontal Revolving-Harrow; his own invention	£5	25	17	1
To William Abraham, of Barnetby-le-Wold, near Brigg, Lincolnshire, for his combined Drag Harrow and Scarifier; invented by Joseph Miller.	Silver Medal.	38	30	1
To Messrs. Cottam and Hallen, of London, Winsley Street, for a Chain-web Harrow, with serrated rings; invented by James Smith, of Deanston, improved by G. Cottam	Silver Medal.	109	97	19
6. AGRICULTURAL CARRIAGES.				
To Richard Stratton, of Bristol, for his Spring Waggon on the equi-rotal cross-lock principle, with Thatcher's breaks attached; his own invention	£20	51	44	3
To Richard Stratton, of Bristol, for his low Manure Tipping Cart, with a Liquid Manure Cistern Body to fit; his own invention	Silver Medal.	52	44	16
To Daniel Coombes, of Shipton, near Burford, Oxon, for his Two Carts convertible into a Waggon; his own invention	£5	91	77	1
To A. White, of Old Sleaford, Lincolnshire, for his Spring Carriage for delivering corn and other purposes; his own invention	£10	89	74	1

AWARD OF PREMIUMS.	Prize.	Reference to Catalogue.		
		Page.	Stand.	Article.
To William Crosskill, of Beverley, for his Cart-wheels with cast-iron Naves and turned Axles; his own invention	Silver Medal.	31	21	14
7. DRILL PRESSERS.				
To John Caborn, of Denton, near Grantham, for his two-wheel Land Presser, with Manure Drill attached; his own invention . . .	£10	26	20	1
8. CHURNS.				
To William Wood, of Knutsford, for his improved motion to an upright Churn; invented by Thomas Wood	£5	107	93	8
9. ROOT STEAMERS.				
To James Richmond, of Salford, near Manchester, for his Apparatus for Steaming Roots; his own invention	£5	72	63	6
10. COUCH RAKES.				
To Richard Stratton, of Bristol, for his Revolving Couch Rake; his own invention	£2	54	44	28
11. HORSE HOES.				
To Messrs. R. Garrett and Son, of Saxmundham, for their Improved Patent Horse Hoe; their own invention	Silver Medal.	44	39	8
To Joseph C. Grant, of Stamford, for his Patent Lever Steerage Horse Hoe; his own invention.	Silver Medal.	65	55	3
To Joseph Scurrch, of Crakehall, near Bedale, Yorkshire, for his light Horse Hoe, with Rake attached; his own invention	£3	73	64	7
12. CHEESE PRESSES.				
To James Smith, of Gloucester, for his single Lever and Screw Press; his own invention .	£3	49	40	6
To Richard Stratton, of Bristol, for a double Lever Press; invented by W. James Gingell .	£3	54	44	32

AWARD OF PREMIUMS.	Prize.	Reference to Catalogue.		
		Page.	Stand.	Article.
13. HAY-MAKING MACHINES.				
To Thomas Wedlake, of Hornchurch, near Romford, Essex, for his improved Spreading or Tedding-machine; his own invention	Silver Medal.	88	73	3
14. TURNIP CUTTERS.				
To Thomas Wedlake, of Hornchurch, near Romford, Essex, for his Turn Plate Turnip Cutter; his own invention	£2	88	73	4
15. CORN AND CAKE CRUSHERS.				
To James Spencer, of Hopton, near Wirksworth, Derbyshire, for his Oat and Bean Mill; his own invention	£5	50	43	3
To the Earl of Ducie, of Tortworth, near Wootton-under-edge, for a Corn Crusher; invented by R. Clyburn	Silver Medal.	8	5	15
To Richard Hornsby, of Spittlegate, near Grantham, for his Cake Crusher; his own invention	£5	36	44	13
16. CORN CLEANERS.				
To B. Millington, of Asgarby, near Sleaford, Lincolnshire, for his Corn Chaffer and Dresser; his own invention	£5	26	19	1
To Joshua Cooch, of Harlestone, near Northampton, for his Barley Hummeller, attached to a Winnowing Machine; his own invention	£3	86	71	2
To John Newham, of Kegworth, near Loughborough, for his Double-blast Winnowing Machine; his own invention	Silver Medal.	10	6	1
17. DIBBLING MACHINES.				
To Messrs. Cottam and Hallen, of London, Winsley-street, for their Two-wheel Double-row Hand or Horse Dibbling Wheels; invented by G. Cottam	£2	108	97	9
18. STEAM-ENGINES.				
To William Cambridge, of Market Lavington, near Devizes, for his Travelling Steam-engine; his own invention	£10	90	75	1

AWARD OF PREMIUMS.	Prize.	Reference to Catalogue.		
		Page.	Stand.	Article.
To Alexander Dean, of Birmingham, for his Travelling Steam-engine; his own invention .	£10	91	78	1
19. WEIGHING MACHINES.				
To H. G. James, of London, 3, Great Tower-street, for two Patent Weighing Machines, of his own construction; invented by M. George, of Paris	£10	101	85	1 and 2
20. MISCELLANEOUS.				
To C. R. Colville, M.P., of Lullington, near Burton-on-Trent, for his Iron Wheelbarrow and Furnace for melting and transporting gas-tar; his own invention	Silver Medal.	3	1	2
To John Gillett, of Brailes, near Shipston-on-Stour, for his Patent Rick Ventilator; his own invention	Silver Medal.	4	2	1
To the Earl of Ducie, of Tortworth, near Wootton-under-edge, for a Self-registering Corn Meter; invented by R. Clyburn	Silver Medal.	8	5	16
To Edward Hill, of Brierley Hill Iron-Works, near Dudley, for his Wrought-iron Cow-crib and Sheep-rack; his own invention	Silver Medal.	22	16	11 and 12
To Edward Hill, of Brierley Hill Iron-Works, near Dudley, for his Wrought-iron Farmer's Field-gates and Posts; his own invention	Silver Medal.	22	16	13
To George Parsons, of West Lambrook, near South Petherton, Somerset, for his Stack-roof or covering; his own invention	Silver Medal.	49	41	1
To Charles Thatcher, of Midsomer Norton, near Bath, for his Patent Self-acting and Self-regulating Breaks, for carriages, waggons, and carts; his own invention	Silver Medal.	58	44	1
To Messrs. J. R. and A. Ransome, of Ipswich, for their Patent Iron-trussed Whippletrees and Pomeltrees; their own invention	Silver Medal.	84	66	57
To Alexander Dean, of Birmingham, for a Cider Mill; invented by James Ashwid, of Bretforton, Worcestershire	Silver Medal.	98	78	49
To Joseph Hall, of Cambridge, for his Weed and Bush Extractor; his own invention	£2	100	82	6

AWARD OF PREMIUMS.	Prize.	Reference to Catalogue.		
		Page.	Stand.	Article.
To J. B. Denton, of Southampton, for his Map in Relief, showing the water-courses, levels, &c. of a district; his own invention	Silver Medal.	113	106	1
To William Hutchinson, of Derby, for his Cast-iron Thrawl, or Barrel-tilter; his own invention	£2	114	109	1
To Andrew Notman, of Painswick, Gloucestershire, for his improved Drainer's Level; his own invention	Silver Medal.	115	111	1
To Messrs. J. R. and A. Ransome, of Ipswich, for their general Collection of Implements, and superior workmanship	Gold Medal.	75	66	1 to 58

Ploughs.—A chasm will this year appear in the record of the draught and performance of the general collection of ploughs, first commenced at Liverpool. This is the more to be regretted, since at no previous Meeting had the exhibitors exerted themselves so strenuously to present this implement in a state of high perfection, and adapted to so many varieties of soil. A great number of ploughs were put to work on Mr. White's farm at Rough Heanor, and inspected by the Judges; many of them with unqualified satisfaction. They would particularize, as worthy of high commendation, those produced from the manufactory of Messrs. Ransome, composed entirely of iron and steel. The beams of these ploughs are constructed on the *truss* principle, which, though novel in its application to the plough, has long been appreciated by mechanics as possessing the greatest stiffness combined with lightness. It is this consideration which has induced those makers to abandon the use of wood, heretofore chiefly used by them for this part of the plough in preference to a beam of solid metal. The structure of their improved iron beam is such as to destroy lateral vibration, particularly at its root or junction with the body of the plough; it admits also of a neat and powerful fixing, as well as ready adjustment of the coulter.

Tremor in mechanism is well known to consume power uselessly; and, in the case of the plough, vibration in the beam, though it be insensible to the eye, renders the guidance of the implement more difficult, and its work less exact. The circumstance of increased stiffness attending mere weight of matter, may have been one cause why the heavier ploughs have not unfre-

quently been found to require less force of draught than lighter ones, for an equal weight of soil moved; but stiffness is not incompatible with lightness, and a diminution in the weight of an implement, when perfect action is otherwise secured, must be attended with economy of power, or, what is the same thing, with a diminution of resistance, whence truer work results.

It is also important that the stilts or handles should be stiff enough to transfer the effort of the holder to the body of a plough, with the least expenditure of his strength; for, the easier its guidance, the greater will be the certainty of the labourer's attention to his business. This property has also received the care of Messrs. Ransome, and, together with the simple means applied for adjusting and replacing the mould-boards, shares, and wearing parts of the various ploughs exhibited by them, testified to the thought and ability bestowed on the most minute details of an implement which still maintains its claim to be the most indispensable, as it was probably the earliest invented, auxiliary to human labour in tilling the soil.

Mr. Howard, of Bedford, again produced his wheel-ploughs, so much admired and rewarded at the Bristol Meeting, which appeared from their action to have lost nothing of their excellence.

Mr. Hill, of the Brierley Hill Iron-Works, near Dudley, exhibited several specimens of Mason's plough with pulverizing knives. On trial they were found to effect an amount of comminution which the Judges had scarcely anticipated in a soil of such tenacity as that at Rough Heanor. From experience in the use of this implement by two of their number since the Bristol Meeting, and by accounts received from other agriculturists, the expectations expressed in the last Report, of the practical utility of this combination, in certain suitable soils, may be considered to be in course of realization.

The stand of Mr. E. D. Falkner, of Fairfield, near Liverpool, contained a variety of substantial and well-constructed ploughs, by Mr. E. Brayton, of Dykesfield, near Carlisle, which acted well; and it was a matter of particular regret to the Judges that they were unable to compare the work and draught of a three-wheel implement by this maker with others.

A double-furrow plough, by Messrs. Barrett, Exall, and Andrews, of Reading, gave great satisfaction, as also some single ploughs by the same firm, especially their one-wheel light-soil plough, rewarded at Liverpool.

The swing-ploughs exhibited by the Earl of Ducie, and manufactured by Mr. Clyburn, were specimens of excellent workmanship and construction, and justified on this occasion the opinion formerly given of their merits. The same may be said of Mr. Law's of Shettleston, near Glasgow, of Messrs. Ransome's,

Mr. Howard's, Messrs. Barrett and Co.'s, Mr. Brayton's, Mr. Scurrch's, Messrs. Sanders and Williams's, and those of other makers. Of the wheel-ploughs several were readily convertible to the swing kind, and furnished with variously formed mould-boards to suit the condition of different soils.

Drill-Ploughs.—Three ploughs, with single-row drills, were produced; to one of which, constructed by Mr. John Meakin, farmer, of Spondon, near Derby, a silver medal was awarded, it being, in the opinion of the Judges, the best implement of the kind they yet had seen. Motion is communicated to the seed-apparatus from the plough-wheel, and the seed is immediately covered by a small light harrow, or roller, according to the kind of seed sown. This plough executed its work neatly, and the drilling apparatus was readily thrown out of gear at the land's end.

Sub-Pulverizers.—Under this or some synonymous title a variety of implements was exhibited, of greater or less merit. The object of by far the larger number was to effect pulverization or comminution of the soil below the depth of common ploughing—not the breaking of it up in lumps or masses. In this respect the makers may be said to have profited by the example set by the many-tined tool of the Hon. M. W. B. Nugent, shown and rewarded at Bristol, which again appeared, with improvements for its management from the hand of Mr. Clyburn; but the opportunity did not serve for ascertaining their value, much to the regret of the Judges.

Mr. Carson, of Warminster, produced a sub-pulverizer, on three wheels, having a lever for raising the tines out of the ground at the land's end, or when meeting any formidable obstacle. This machine acted in a manner to elicit warm encomiums. The main frame is disposed in the shape of a right-angled triangle, the fore wheel being placed at the vertex, and the hind wheels at the extremities of the base. The leading and right-hand hind wheels are in a line, and travel in the furrow made by a plough, thus assisting to guide the machine, and to determine in part the depth to which the tines plunge; whilst the left-hand wheel rolls on the land side, and serves to maintain the whole in *equilibrio*. From this arrangement of parts it is evident that *fair swimming* must result; and it was found that the disposition to pitch and roll, common to the ordinary swing subsoil-plough—properties which render it difficult to be handled and managed so as to preserve even tolerable uniformity of depth and action in many soils—is entirely overcome. As respects ease of guidance, this implement worked, under the eye of the Judges, through long spaces without holding, maintaining a straight path and very even depth in the stiff clay operated upon. At the end of a bout the tines were raised out of the ground and set in again without stop-

ping the horses, and with no greater trouble to the holder than is required by the common plough. The leading-wheel is on the castor or Bath chair principle, and therefore turns with the horses; the hind-wheels can be set to various depths below the frame in order to regulate its parallelism with the surface.

On first examining this machine in the show-yard, it was feared that the hind furrow-wheel might press too heavily and flatten the lightened earth; but, on trial, no such effect was perceptible. In fact, some additional weight was requisite to bring that wheel to a bearing; its principal use is for turning and setting in at the land's end. The horses may be yoked in line or abreast, as may seem best to the farmer, according to the state of his land.

It will be understood that there is a second frame, in which the working tines are fixed. This is also of the right-angled triangular shape, and is supported by and under the main frame. The apex of this frame is jointed to one extremity of the lever, having its fulcrum on the beam; the after part or base of the triangle swings upon a rod or centres above the hind-wheels. Thus, by elevating or depressing the lever, the tines fixed in this frame are lowered into the soil or raised out of it, the degree of depression being determined by a stop and holes in an arched guide through which the lever passes. Each tine is separately adjustable. A general resemblance of arrangement between this implement and that of the brakes or scarifiers will be observed; but, on closer examination, it will be acknowledged that no slight originality of design has been grafted by Mr. Carson on a practical acquaintance with the requirements of a subsoil-pulverizer. Five tines, set at different depths, may be used in the furrow, or one only; and it is capable of being employed as a scarifier with ten tines; but the Judges did not see its action in the latter capacity. The moderate price of this implement, stated to be 8*l.*, is also no slight additional recommendation of it to agriculturists. A premium of 10*l.* was awarded to Mr. Carson for this admirable invention.

An excellent many-tined pulverizer and stirrer for lighter operations was exhibited by the Earl of Ducie, deriving its origin from Mr. Nugent's instrument, and adapted by Mr. John Morton, of Chester Hill, to sub-pulverizing after the common plough, and for stirring the soil between the rows of turnips, &c. This light and easily-managed implement is furnished with one leading-wheel. The frame contains eight mortices for narrow tines, and is so disposed that the tines may follow the plough in a nine-inch furrow, and loosen the subsoil, or be set to comprehend a breadth of 18 inches, and pulverize the general mass of upturned soil, or, as aforesaid, work between rows. The Judges

observed its action when five tines were set at different depths (all being adjustable), acting in a clay soil, at Rough Heanor, which had fortunately been brought into proper condition to exhibit the properties of such a tool. It worked cleverly with a pair of horses, and, as it passed along, the soil had the appearance of being thrown into a perfect state of commotion and mixture. The style in which it was turned out of hand did great credit to the maker, Mr. Clyburn. The Society's silver medal was awarded for this implement.

Surface and Subsoil.—To Mr. John Bruce, of Tiddington, near Stratford-on-Avon, 5*l.* were adjudged for a novel and apparently very useful combination of two subsoil tines with the common wheel-plough. The show-yard contained implements having stirrers upon the plan of the Charlbury subsoil, *i. e.* affixed to the hinder part or heel of the plough. Mr. Bruce's contrivance is on a different, and it is thought a superior, principle. He applies to the right-hand side of his plough-beam, and about parallel with the point of the share, a frame containing two tines, adjustable as to width and depth, which, by means of a lever brought convenient to the ploughman, can be raised out of work at the land's-end, and set in again on the next bout with great readiness. The tines stand off from the beam so as to work to the depth of about 5 inches below the furrow-slice last turned, and thus loosen the soil previously trodden by the horses, leaving the slice also in no inconsiderable state of division. On trial, the action of the tines did not at all appear to derange that of the plough, or throw additional labour on the holder. The Judges have learnt that this combination has been used and much approved by practical farmers in the inventor's neighbourhood.

From observing the effect of this arrangement, it has been suggested to Mr. Bruce, that in certain soils, with the addition of Mason's knives, a very complete disintegration of the surface, as well as the loosening the subsoil, would be effected off the plough at one operation. This is in course of trial. The treble combination may be found to be too complicated for general purposes, but yet very manageable in many soils, and particularly suitable for drill husbandry, which requires a finely comminuted preparation, rather than that the furrow-slices should be packed into masses, as for the broad-cast system.

Neither agriculturists nor their mechanics seem yet to have quite comprehended that the machinery for executing the drill system in perfection should be accommodated expressly to the object in view. The broad-cast system, or sowing after the plough, necessitates the formation of angular-topped, ridged furrows, for the reception of the seed, and the harrow is necessary to cover it. But a strict adherence to these methods is obviously

unnecessary for drill-husbandry, as the masses must be broken up and pulverized by some means before the surface be fitted for drillage. The more recent addition of manure to that of seed in drilling also renders a thoroughly pulverized and clean condition of the soil still more important, as the manure must be buried at a greater depth than the seed. The present preparation for the drill consists in pulverizing the ploughed surface by the harrow, which has to tear to pieces the roots of plants, such as rye-grass and timothy; an operation which requires several passages of the harrow. These considerations lead to the suggestion that, by the use of the skim-coulter with the plough, which divides the roots of plants, and buries them, together with the application of Mason's knives, and perhaps a pair of vertical dividing blades, a cheaper and more perfect preparation of the soil would be obtained for the autumn drilling of ley lands with wheat than by the present system. The good effect of the skim-coulter is well known; it is highly prized and much used in some districts; and the plough furnished with it was proved at Bristol to require no additional power. It was also proved that Mason's knives did not add more than 15 per cent. to the draught of the plough.

The object of the foregoing observations is to engage the implement-makers and agriculturists to consider whether preparative tools may not be devised better calculated to economize and perfect the preparation of land for drill-husbandry than those now employed. Constructive skill has triumphed over the mechanical difficulties of the drill; but it seems to have been forgotten that the previous tillage operations are also susceptible of a special adaptation to the final process; and that, by diminishing the number of operations, and consequently the number of times necessary for horses to travel over and poach the surface, economy and profit will result.

Water-furrow or Boat Plough.—This implement was not tried in the field, but was known to the Judges as useful in clearing the bottoms and levelling the sides of the furrows in clayey soils; also for forming channels for carrying off flushes of surface-water. It is a cheap tool, principally formed of wood, its section representing the fore-part of a boat, whence its name. The two wings overlap the edges of the furrows, leaving them and the bottoms smoothly rounded and clean; giving an exceedingly neat finish to a newly-sown wheat field. It is the invention of a celebrated agriculturist, Mr. Stickney, of Ridgemont, in Holderness, where it is highly appreciated. A silver medal was awarded to the maker, Mr. John Caborn, of Denton, Grantham.

Stubble-paring or Skim Plough.—Four implements appeared in the show-yard responding to the Society's wish for the exhibition of improved stubble-paring ploughs. The Judges had no

hesitation in selecting for reward the iron skim in the collection of Mr. Hill, of Brierley Hill Iron-works, near Dudley.

This plough was invented by an amateur, nearly twenty years since, in the neighbourhood of Pauntley in Gloucestershire, and had scarcely travelled out of its native parish until Mr. John Allen Stokes (to whom the Society is already chiefly indebted for disinterring and making known Mason's pulverising plough), struck by its effective appearance at a blacksmith's shop, ordered one, and introduced it into his own neighbourhood, "where its use," he observes, "has extended more rapidly than any other implement I am acquainted with, excepting Gardner's turnip-cutter." The Judges cite this opinion, given in reply to their subsequent inquiries, as the same effective appearance struck them, and induced them to reward it with a medal, though unable to test its qualities on a stubble. This skim cuts a slice of 2 feet in width, and is adjustable from 2 to 8 inches in depth. It is represented as capable of completing 3 acres per day, with a team of 3 or 4 horses, according to the depth of cut. Mr. Stokes speaks of it as an excellent instrument for preparing the cleansing of stubbles, and it is constructed by Mr. Hill at a very moderate price.

Draining Ploughs.—Three forms of plough for economising the labour and cost of drainage were produced by different machine-makers, without the stimulus of any prize offered by the Society. Of these there could be no question as to superiority in design and probable effectiveness; and 10*l.* were awarded to Mr. David Harkes, of Mere, near Knutsford, for his implement. A partial trial was made of it in the grass land of the show-yard, the cut being about 12 inches deep, and as many wide. The sod was well raised, and thrown to a distance from the excavation in a continuous line; and gave promise of this implement's fulfilling the intentions of its inventor, and becoming a valuable addition, in suitable soils, to the stock of agricultural mechanism in one of its fundamental and most important branches. The acting parts are supported on four wheels, with simple and efficient contrivances for determining the depth of cut, the raising of the excavator from the ditch at the end of a land, and its easy guidance.

Harrows.—The Society's offered prize of 10*l.* for the best set of harrows was divided between Mr. Howard, and Messrs. Sanders and Williams, of Bedford. Both these makers produced the implement in so effective a form as to render a judgment as to any decisive superiority extremely difficult without a lengthened practical trial.

Mr. Stratton, of Bristol, exhibited the harrow contrived by Mr. Evan W. David, of Radyr-court, rewarded at Bristol, and

which is again highly commended for its strength, lightness, and adaptation to general purposes.

A harrow constructed on an original principle was produced by Mr. Robert Hopkin, of Hartington, near Ashbourne, Derbyshire, which appeared on trial to be worthy of encouragement, and 5*l.* were awarded to the ingenious inventor. The harrow is circular, like a cart-wheel, and lies flat on the ground, the tines passing through the felloes. A horizontal revolving motion is communicated to it, as it is drawn forwards, by means of an endless chain proceeding from a carriage in advance, and passing round a pulley fixed upon, and concentric with, the rim of the harrow, but of smaller diameter. The power is derived from the carriage-wheels, as in other cases. The execution of the apparatus was very imperfectly adapted to give effect to this novel idea, but the principle, perhaps, merits the attention of mechanics, as the double action compounded of the progressive and circular movements appeared to produce a very considerable comminution of the soil. Several circles of teeth may be inserted in the same wheel, and if it be found that the power used in giving the spinning or revolving motion be paid for in the quantity or quality of the effect, this construction might prove advantageous as a surface-pulverizer. The experiment should be made with short small teeth.

Mr. Smith's (of Deanston) chain-brush or web-harrows, rewarded at Liverpool, were exhibited by Messrs. Cottam and Hallen, of London, with a change in the structure of the edge of the rolling-rings, or discs, the latter being notched or serrated instead of plain, and therefore presenting increased abrading surface. The harrow tried was 5 feet square, covering, therefore, an area of 25 square feet, and weighing 392 lbs. This implement is adapted for merely superficial operations, such as covering small grass-seeds, &c., as it rubs or brushes the finest pulverulent soil upon the seed; in addition to which it acts as a light compressor or roller, for, though the direct pressure is only about 16 lbs. per square foot, this weight continues to act through 5 feet in the space passed over, and tends to set down the earth upon the seed, which the common harrow cannot effect. It may also prove useful for spreading and pulverizing manure laid upon meadow-land in the winter, and for operations where the teeth of harrows might be injurious or unsuitable. It is right that the Judges should observe that they noticed its action at a time when the clay soil at Rough Heanor was very dry, and in a peculiarly fit state for displaying its good qualities. A silver medal was awarded to Mr. Cottam for his improvement.

A variety of other harrows was offered to the agricultural world, among them a new lever-harrow, by Mr. Joseph C. Grant,

of Stamford, and a new revolving and sowing harrow by Mr. Harkes, scarcely yet perfected, the merits of which, with others of the revolving kind, time did not suffice for ascertaining.

Scarifiers.—After a minute examination of the various implements contained in the show-yard under this or other nearly synonymous title, the Judges determined on recommending the Council to appoint a future and more accurate trial than could be then entered upon, of the respective merits of the Uley cultivator exhibited by the Earl of Ducie, and of Biddell's scarifier as improved and exhibited by Messrs. Ransome. Both these powerful implements have received prizes at previous meetings, and are most effective for breaking up and cleaning land after lying long under crop, or infested with couch, &c. The scarifier is, indeed, become little less indispensable to the agriculturist than the plough, and its utmost attainable perfection well deserves the Society's earnest encouragement.*

Mr. Wm. Abraham, of Barnethy-le-Wold, near Brigg, Lincolnshire, produced an implement invented by Mr. Joseph Miller, for which the silver medal was considered to be due; being a cheap, light, and effective tool for cleaning light soils. It partakes of the nature of Finlayson's harrow and Biddell's scarifier.

Clod-crushers.—Mr. Crosskill's implement remains undisturbed in the opinion of the Judges as the most efficient of its class yet introduced. They would not, however, withhold from Mr. Joseph Hall, of Cambridge, much commendation for the crusher produced by him; but, on trial against Mr. Crosskill's in the clay of Rough Heanor, well and purposely prepared for testing the qualities of such tools, it appeared to them that the simple, serrated, independent series of wheels composing Mr. Crosskill's implement, effected more perfect pulverization than Mr. Hall's more complicated tool; also, that the latter is less well adapted for rolling young wheat, &c., to which Mr. Crosskill's crusher is so advantageously applied.

A spike-roller or clod-crusher, of excellent workmanship, was exhibited by Mr. Hornsby; but, from some misapprehension, it did not reach the field in time for trial. A rough roll, by the same maker, was tried, and much approved; but its application is limited, as compared with Mr. Crosskill's.

Messrs. R. Garrett and Son, of Saxmundham, brought out an improvement which more expressly applies to the convenience of the farmer than to the improvement of the clod-crusher; viz., the furnishing it with wheels which are raised from the ground when

* These implements were, with the consent of the makers, subsequently placed in the hands of Mr. Jaques, of Easby Hall, near Richmond, Yorkshire, who has undertaken the task of reporting to the Council his opinion of their respective properties. †

at work, but remain attached to the implement. The wheels are thus at all times ready for travelling it, instead of their having to be sought for, probably at some distant part of the field, when the work is done.

Rollers.—The Judges did not see occasion to award any special prize in this class, though many well-contrived rolls, and of various dimensions and arrangements, were presented. The principal novelties were two implements of wrought-iron in the collection of Mr. Hill, of Brierly Hill Iron-Works, near Dudley. The general advantages contemplated by the substitution of wrought for cast iron, as the material of rolls, are the obtaining enlarged diameters without increase of weight, and the diminishing the chance of breakage. One of these rolls, formed of two separate cylinders, was furnished with sliding weights, so as to render it heavier or lighter, ranging between 15 and 40 cwt. in order to accommodate it to different purposes. In commending these wrought-iron rolls, which were well manufactured, the Judges are not prepared to pronounce, with any certainty, as to their durability being equal to those composed of cast-iron; wrought-iron being subject to more rapid decay from oxydation than cast metal, when exposed to the vicissitudes of the seasons. Some experience is desirable to determine this question.

Couch-rakes.—The attention of machine-makers was solicited by the Society to the construction of a rake for collecting couch, which had the effect of bringing forward four implements expressly designed for the purpose. The silver medal was awarded to Mr. Stratton, of Bristol, for a tool which appeared to possess the desired qualifications. The raking apparatus consists of two separate rows of long curved teeth fixed upon a shaft or axis, the points of one of which are upon the ground collecting, whilst the other row stands vertical and empty. The row of teeth collecting is retained firmly in action by two catches, and when filled, the driver gives half a turn to a handle which liberates the catches, when the rakes instantly make half a revolution, the one set discharging its load whilst the other set comes into play. The machine is mounted on three wheels, is calculated to be worked by one horse, and the inventor estimates its capabilities at raking from 20 to 30 acres per day. The Judges were unable to experiment with this new implement on couch land, but are disposed to consider the principle sound, and likely to be efficient in the collection of hay, corn, and stubble, as well as couch. It is also proper to mention that it is designed, on a stronger construction, to collect cane trash in the plantations, for which it was originally contrived, and has been found, in the island of Antigua, to be well adapted.

Drills.—The existing system of drill-husbandry, practically considered, has an origin intrinsically English, though faint traces

of its use are mentioned as of high antiquity. It will not be thought an undue tribute of praise to the English agricultural mechanics, to notice that the implements employed are also of purely English invention; neither the mechanic nor the agriculturist has been indebted to any other portion of the British empire, or to the foreigner, for any improvement in the art itself, or in the machinery by which it is accomplished. To the drilling of seed has been added, within the last few years, the drilling of manures, a process also purely English, and which can scarcely be ranked as secondary in importance even to that of the mechanical deposition of seed. If the annual collection of mechanism sent to the Society's country meetings afford any evidence of the demand for particular implements, or of the progress made in distinct branches of husbandry, then we may, with confidence, deduce that the drill system is advancing with rapid strides. More than sixty implements, expressly designed and employed for the deposition of seed and manure conjointly or separately, called for the examination of the Judges on the present occasion. If to these be added the horse-hoes and other tools auxiliary to the system, it results that one-third of the articles in the tillage and cultivating departments of the exhibition consisted of drilling machinery; and if the ploughs common both to the broadcast and drill systems be excepted from the summary, more than one-half of the remainder was specially subservient to the preparation of the soil for drilled crops, or to their after-treatment. The contemplation of such a display cannot but have been gratifying to the members of the Society, including as it did an adaptation of the drill to almost every species of grain and seed crop, and justifying the encouragement extended by the Society to this pre-eminently important division of the agricultural art.

By referring to the analysis of the exhibition it appears that, of the 61 implements denominated drills and pressers, two-thirds of them combined the deposition of manure with that of seed; thereby testifying to the fast-increasing appreciation of the value of these united processes both by agriculturists and mechanics. The following concise history of the first introduction and progress of the manuring drill-system in Lincolnshire* has been obtained from sources on which it is believed full reliance may be placed; and its relation may have the effect of exciting the farmers of more backward districts to emulate those of a county excelled by none in Britain, in respect of the quantity of its produce, though far inferior to many in the natural fertility of its soil and character of its climate.

* The Judges have set on foot inquiries relative to the origin of manure-drills in the south-eastern counties, but have not yet succeeded in establishing the historical dates to their satisfaction.

"The introduction of manure drills into Lincolnshire is comparatively of recent date. Previously to 1814, small single-row drills, attached to the plough for depositing beans in every alternate furrow, and turnip-seed drills, were the only seed-sowing machines used in the county. In 1814, the firm of Seaman and Hornsby, of Grantham, made a drill for depositing bones with turnip-seed. In 1816, Mr. Gregory, of Nottingham, brought a sample of crushed bones to Grantham market, in a mahogany box, to exhibit to the farmers the perfection he had attained in reducing them to a small size. In the same year several spirited farmers purchased drills for bones. In 1817 these drills became general. In 1819 portable bone-mills were first introduced: these flourished but a short period, giving place to the large fixed stean-mills. In 1828 we first began to drill ashes mixed with bones. In 1839 originated the first attempt to improve the delivery of manure by means of stirrers in the drill-box; and by these improved machines the drilling of compost was effected. At present, 1843, we presume to be able to deposit, by the drill, fold and stable-yard muck with our seed. For the rapid adaptation of the drill to this latter purpose we feel to be much indebted to the stimulus given to our mechanics by the Society. Neither Jethro Tull, the honoured father of the drill-system, nor the Rev. Mr. Cooke, the inventor of the Suffolk drill, dreamed of depositing manure of any kind with the seed; an addition which we consider to belong to the eastern counties' farmers, ambitious only at first to economise their then favourite manure, the bone."

The Society's prize of 30*l.* was awarded to Messrs. R. Garrett and Son, of Saxmundham, for their drill for general purposes. A mode of steerage was applied to this implement, which was thought to be calculated to render its use less difficult to novices, and to ensure straightness in the lines. Facility in the guidance and management of these implements is a property of unquestionable importance, as providing for the more complete and safe action of the horse-hoe. It may not, however, be out of place to observe that experienced drill-men reject refined appliances of this kind as incumbrances. The late Earl of Leicester is said to have remarked that "he would not employ a labourer who could not lead a drill-horse straight from Holkham to St. Paul's."

To Mr. Richard Hornsby, of Spittlegate, Grantham, 10*l.* were adjudged for a twelve-coulter corn and manure drill for general purposes, which bore ample evidence of the care and skill bestowed by him in the construction of this class of machines.

Both the above-mentioned drills were provided with well-contrived apparatus for dropping seed and manure at intervals, should the agriculturist prefer that method to their deposition in continuous trains.

The silver medal was awarded to Mr. Hornsby for a thirty-coulter drill, effecting the deposition of clover and grass-seeds, either separately or mixed, in rows 3 inches apart. This excellent implement facilitates an extension of the drill system, and does much credit to the inventor.

A third implement by the same maker was considered to be equally, if not still more deserving of encouragement and approbation; viz., a cart with drills attached for both ridge and flat culture, adapted for sowing from two to four rows of turnip-seed and bones, or other pulverized manure. This is another and important step made towards the perfection of the drill system, by accelerating the operation, and diminishing labour in the field. The silver medal was given to Mr. Hornsby for this original combination of drills with the manure-cart.

To Mr. Thomas Hunter, of Ulceby, near Barrow-on-Humber, Lincolnshire, 5*l.* were awarded for an excellent ridge turnip and manure drill, the invention of Mr. Cartwright. Without the aid of diagrams it would be next to useless to attempt to convey a distinct idea of the particular mechanism adopted by the different makers for discharging manure, and ensuring uniformity in its deposition. A safe and perfect judgment of mechanical sufficiency, or of the superiority of one method over another, can, in fact, scarcely be arrived at without a patient trial. That a considerable advance had been made during the past year in the manuring faculty of the drill was manifest in most of the machines exhibited; and the Judges were disposed to estimate very highly the arrangements of Mr. Hunter's simple apparatus, which he represented to be quite effective for drilling putrescent manure; yet they did not feel so satisfied of its powers as to award to him the highest prize, which they might otherwise have done, though his drill was limited to turnip culture. They now think it their duty to report that, since the meeting, one of their number has carefully tried this drill, and found it perfectly capable of depositing well-chopped fold-yard manure mixed with soil, without the aid of the riddle, and with as much regularity and precision as has been hitherto effected with dry bones, ashes, or compost. He is also of opinion that, with this drill, moisture not being an impediment, ashes are unnecessary as assisting in bringing compost to the drilling state; and, further, that all that is required for the preparation of fold-yard or stable muck is, that it should have a certain degree of fineness so as to admit of its being covered by soil when deposited. He is satisfied that Mr. Hunter's drill is capable of uttering any required quantity of such manure, and of passing lumps, without obstruction, even of 5 inches' diameter.

Mr. John Caborn, of Denton, Grantham—the whole of whose collection showed an acquaintance with sound mechanical princi-

ples as adapted to agriculture—produced a well-contrived convertible corn and turnip drill, more especially remarkable for its possessing a peculiarly simple and efficient manure stirrer. It was rewarded with the silver medal. The axis of this stirrer, instead of being straight, and having tines, forks, or otherwise-formed limbs projecting from it, in order to agitate the manure and prevent its arching in the box, is fashioned of a continuous serpentine figure from end to end of the box. The simple change of figure adopted by Mr. Caborn is no inconsiderable improvement in the mechanism applied to effect manure delivery.

A premium of 5*l.* was awarded to Mr. James Smyth, of Peasenhall, near Yoxford, for the adaptation of a nine-coulter corn drill to sowing hilly land. The purpose of the inventor is simply and ingeniously managed, as will be understood in few words by stating that the seed-box and delivering cups are always maintained in a horizontal position whilst crossing a hill, so that, whether in going or returning, the seed is prevented from shifting to one end of the box. This is accomplished by suspending the box on levers, and giving motion to the cup-axis by wheelwork at both ends; so that on raising either end of the box by the lever, in order to adjust it to a level line, one set of wheels is out of gear, whilst the other set gives rotation to the axis and effects the delivery of the seed. In other respects, too, the arrangements of this machine did much credit to Mr. Smyth.

Mr. Crosskill's grass-land cultivator and manure depositor, rewarded at Bristol, was again considered, by reason of its utility, and the subsequent improvements made in it, to merit a silver medal.

Mr. Huckvale's liquid-manure drill, mentioned in the Bristol report, and rewarded at that meeting, was produced in a more finished and effective state. There can be no question as to this machine now possessing the requisite qualifications for applying any liquid dressing, and in any desired quantity, to plants in rows. The barrel of the one exhibited held 100 gallons, dimensions which may be increased. The inventor recommends it as a convenient mode of distributing soluble or miscible manures, as saltpetre and guano, which may be deposited below the seed; or as a surface-watering machine in a dry seedtime. The fluid is delivered by cups, or small scope-wheels, which revolve in a water-tight trough supplied from the cask or cistern. The quantity of fluid taken in and delivered by these scope-wheels is regulated by a metallic shroud or band, which passes over their face, and is adjustable so as to increase or diminish the size of the apertures. For dressing grass-land this machine has the advantage over common liquid-manure carts of depositing it with perfect uniformity throughout the space passed over, as the discharging-

wheels revolve a definite number of times in a given distance, at whatever pace the horse may be travelling. The silver medal was adjudged to Mr. Huckvale for his perseverance and ingenuity in adapting this novel idea to practical uses.

A seed hand-barrow was exhibited by Mr. James Smyth, jun., of Peasehall, for the more accurate sowing of small seeds by machinery than can be done by hand-scattering. The seed-box covers a considerable breadth at once; and precision of delivery is secured by cups, instead of brushes, which are the more usual but less exact mechanical means used for meting out small seeds by the drill. The revolution of the cup-axis is derived by toothed gearing from the barrow-wheel. The arrangement is highly creditable to Mr. Smyth; and, by reason of its lightness, cheapness, and efficiency, this sowing-machine will prove useful to the small farmer.

Drill-Pressers.—Ten machines for forming drills by pressure were brought forward by various makers, the greater number of them bearing the stamp of improvement, particularly as adapted to the deposition of seed and manure. After a careful examination, the Society's prize of 10*l.* was awarded to Mr. John Caborn, of Denton, Grantham, for a two-row implement, having wheels 3 feet 8 inches in diameter, and comprising very effective arrangements for depositing the manure in the trenches. The price of this machine is also moderate.

Dibblers.—The collection of the Earl of Ducie contained the dibbling and sowing machine with five wheels, invented by James Wilmot, rewarded at Liverpool, and described in that Report. No improvement was observed on the original specimen, but the machine was reported as gradually coming into use.

Mr. Stratton, of Bristol, exhibited the single-row dibbling wheel used by Mr. Miles, M.P., of Kingsweston, chiefly for forming the holes to receive the seed of mangold-wurzel. It is a tool of the simplest kind, gives mathematical precision to the spaces desired between the plants, and is represented by Mr. Miles as leaving the holes quite sufficiently true and clear for the purpose. It consists of a light wheel, furnished on the rim with dibbling points, set at equal distances from each other, and making holes 2 inches in depth. The wheel is comprised in a frame, and worked by a man.

Messrs. Cottam and Hallen, of London, produced a two-row dibbler, with wheels 3 feet in diameter, the principle of which is precisely similar to that last-mentioned, but rendered adaptable to a greater number of purposes. The machine is entirely constructed of light iron. The dibble points are adjustable to any distance from each other; and the wheels can be set at any space asunder from 4 to 36 inches. A man can work it on light soils,

and it has a pair of shafts for a pony on stiffer lands. A premium of 2*l.* was adjudged to Messrs. Cottam and Hallen for this well-devised implement.

Horse-Hoes.—The well-known horse-hoe of Messrs. R. Garrett and Son, rewarded both at Liverpool and Bristol, was exhibited with improvements, rendering it still more complete in its fittings and adaptation to follow the drill in the various forms of culture to which the latter implement is applied. The silver medal was awarded for these improvements.

A silver medal was also given to Mr. Joseph C. Grant, of Stamford, for his new patent steerage-lever horse-hoe, which appeared to possess the requisite properties for cleaning drilled crops. It is provided with a very manageable and efficient steerage, and a lever power for instantly and readily raising the hoes from the ground.

For hoeing and scuffling between rows of turnips, potatoes, &c., the show-yard abounded with implements, most of them well known, and constructed, with more or less skill, in most parts of the kingdom. A premium of 3*l.* was given to Mr. Joseph Scurrch, of Crakehall, near Bedale, Yorkshire, for a turnip and potato horse-hoe, having a small but effective lever-rake attached to it, which collects the weeds as they are hoed down, and prevents them from growing again. The rake is in an instant freed of its collection by the action of the lever. It is a cheap and good implement.

Some remarkably well-made tools of the scuffling kind were also exhibited by Mr. William Wood, of Knutsford, Cheshire.

Haymaking Machines.—Mr. Wedlake, of Hornchurch, produced a spreading or tedding machine, for which the silver medal was adjudged, as being the most complete of its kind yet exhibited. It has two separate cylinders, with a ready means of reversing their motion, so as to scatter the grass in the usual way or leave it behind in rolls, on the plan of Mr. Lovell's machine, rewarded at Bristol. This faculty of reversing the motion is an advantage, as the wet heavy grass of the swath requires tossing and spreading evenly; whereas, as it approaches in dryness to the state of hay, the more quiet action of turning it is considered to be preferable, less seed being shaken out. The Judges, however, have ascertained, from several farmers using and highly approving these machines, that there is still room for improvement in them. The journals are not yet sufficiently secured against clogging, and time is lost in freeing them from grass. An extensive and experienced hay-grower observes that, with one horse, and changing the horse every three or four hours, Mr. Wedlake's machine will strew more than 2 acres of newly-mown heavy grass per hour, in a manner far superior to the hand; and

that he considers its performance fully equal to the work of 20 haymakers. There is no harvesting-machine yet introduced which economises labour to such an extent, or tends to save a crop so surely, as the mechanical haymaker, and it is very desirable that the manufacturers should use every exertion to remedy such defects as may abridge the utility of so valuable an implement.

Horse-Rakes. — Several horse hay-rakes were exhibited, but the Judges adhere to the opinion formerly expressed, that none of them excel the patent rake of Mr. Joseph C. Grant, of Stamford, rewarded at Liverpool and Bristol, which was again produced by him, with improvements tending to secure its more perfect action, durability, and convenient management.

Horse-Engines. — The horse-engine, or horse-work, as this machine is more commonly but incorrectly named, has become — where steam is not used — indispensable as a prime mover of barn-machinery, more particularly as applied to threshing-machines and chaff-cutters. For these and other purposes it is extensively and economically used, whether fixed or as travelling from farm to farm on hire. The Judges have to notice the production of two novelties in this class by Messrs. Ransome. The first was an arrangement of the travelling-engine, which obviates the necessity of unloading it from the carriage or removing the wheels. By these means, too, the main shaft, which communicates the power to the object, is kept above the horses' backs, so that they pass under instead of having to step over the shaft, as on the common plan. The second had a more important purpose in view; viz., the establishing a kind of intermediate mechanism, planted between the engine and the objects to be set in motion, from which (without disturbing the engine or any machine applied to it) any other machine may be driven, and at any part of the barn which may be most convenient for its use. It would occupy too much space to attempt to describe this arrangement; nor could it be done justice to without drawings. Suffice it to say that the purpose was accomplished in a simple and satisfactory manner. This contrivance for diverging power in various directions will be found useful where it is desirable to put in motion several machines at the same time by the same horse-engine, provided no one of them requires a greater force than one horse: thus, the chaff-cutter, the turnip-cutter, and the domestic flour-mill, or a pump, &c., may be driven together or separately. There is certainly no part of the farmer's establishment which more commonly needs a thorough revision than that devoted to his barn-operations. It is too often formed without plan; is too often devoid of systematic arrangement; and seems rather to resemble an incongruous mixture of things of no value, than of mechanism, in the disposition of which space and

method should be considered as elements of the first consequence. As an appliance to palliate existing defects of this nature, and as the germ of a superior system of mechanical arrangement in barns, Messrs. Ransome's contrivance merits the highest commendation.

Steam-Engines.—The truth of the last remarks will receive the acknowledgment of all those agriculturists who have applied or desire to substitute fixed steam-engines for manual or horse-power, as the prime mover of their barn-machinery. Then it is that the disadvantage of crippled space and previously bad arrangements becomes prominently apparent, from the difficulty of connecting the power with the machines, in such manner as to unite economy of outlay with convenience as respects the fold and stack yards. These are points especially deserving of study by persons erecting new farm-buildings.

The show-yard contained six well-constructed steam-engines, three of which were of the travelling kind; and two of these were set to work at Mr. White's, of Rough Heanor. A premium of 10*l.* was awarded to each of the exhibitors—Mr. William Cambridge, of Market Lavington, Wilts, and Mr. Alexander Dean, of Birmingham. The Judges cannot presume to pronounce an opinion as to the comparative merits of these engines, to determine which would require a longer and much more severe trial than they were able to submit them to. Both appeared to possess the qualifications necessary for good working and safety.

It will be in the recollection of the Society that the first portable steam-engine which appeared at any of their meetings (and, it is believed, the first of the kind introduced to the notice of the agricultural world) was that exhibited at Liverpool, in 1841, by Messrs. Ransome; of the performance of which, during a short period, a separate report was made. This engine, on the discipline, was afterwards converted into a locomotive, and again tried at the Bristol Meeting, in conjunction with a travelling engine by Mr. Cambridge, and both received premiums. The Judges may now report that the manufacture and use of travelling steam-engines is become a systematised business. In Lincolnshire, steam-engines both fixed and portable are becoming general on large farms. They are also let on hire. The charge made for threshing is necessarily dependent on the quantity of grain capable of being threshed out in a given time, and whether the straw has been reaped or mown; also, in some degree, on the amount of work to be done. It will be useful to the Members of the Society to be informed that the hire of engines for wheat and barley threshing varies between 1*s.* and 1*s.* 3*d.* per quarter, including the wages of the engineer and the feeder of the machine; the farmer usually finding coal and the assistant hands. The

travelling steam-engine is also employed to give motion to draining and other apparatus, which may only require to be put into occasional activity. Incidentally to this subject it may be of consequence to observe that the Judges have ascertained that the Yorkshire Fire Office will insure at 3 per cent. where these engines are used; their usual charge being 2 per cent. It is believed that other Offices effect assurances at the same rate. It is the opinion of the Judges, from the attention they have given to the furnace and boiler arrangements of these engines, that little or no danger is to be apprehended from their use; and that, by proper representation and inspection, all the fire-offices would speedily release the farmer from a tax which bears heavily upon him and the machine-maker. At the same time it behoves the employer to satisfy himself that the engineer adopts the best known precautions against the issue of sparks or flame. Coke is a better and safer fuel for these engines than coal; it is also cheaper wherever it can be procured at only one-fourth higher price than coal, weight for weight.

Threshing-Machines.—Two of these machines were selected for trial, and taken out to Mr. White's farm. One of them, constructed by Mr. Cambridge, was driven by his own travelling steam-engine, exerting probably at the time a power of about three horses. The performance of both threshing-machine and engine was satisfactory to the Judges, and creditable to their maker. It will not be expected that the Judges can assign the cost of threshing by steam from such short experiments as they are able at any time to superintend. The yield is so dependent on the condition and quality of the straw and corn to be threshed, that no rule of produce can be safely quoted in terms of the power and time expended. The average rate of hire, which includes that of the threshing-machine, has been already cited, to which will have to be added the cost of fuel, a variable but small item per quarter, and that of the assistant hands. On obtaining these facts from the makers, the farmer will be able to determine the economy of steam-threshing in his own locality, compared with the flail or the horse-engine.

A wheat threshing-machine by Messrs. Ransome was distinguished by some novelties which deserve notice. It was driven by the horse-engine previously referred to as having the connecting shaft over head. Its chief characteristics consist in an arrangement of the beaters, so that they are fed with the straw and ears in a horizontal instead of a vertical direction, by which means the straw is delivered flat, straight, and unbroken. Thus, the straw after being threshed issues in a state ready for immediate tying up. The machine is also furnished with a contrivance for conveying and shaking the straw. The Judges cannot but

highly commend Messrs. Ransome's efforts and ingenuity in perfecting a species of threshing-machine more particularly coveted by farmers residing near large towns, to whom the production of clean unbroken straw is frequently an object of more importance than the threshing out the greatest possible quantity of grain in a given time.

Corn Cleaners.—The collection of these machines was larger than at any previous meeting, but the Judges take occasion to remark that some of them bore rather the external appearance and polish of cabinet-work, or articles of household furniture, than of serviceable barn-tools. Good workmanship is as important to the efficiency of the light winnowing machine as it is to the sturdy horse or steam engine; but there cannot be worse taste in mechanism than the overloading it with finery. The good sense of farmers is pretty sure to cause them to leave such things in their makers' hands rather than to transfer them to their barns. Many excellent implements of this nature were, however, exhibited, and after trial a premium of 5*l.* was awarded to Mr. Bryan Millington, of Asgarby, near Sleaford, for a machine which united simplicity of construction with usefulness. Its distinguishing advantage consisted in the first operation termed *chaffing*, which it effected with great celerity, producing a clean sample of corn.

A silver medal was given to Mr. John Newham, of Kegworth, Leicestershire, for his double-blast winnowing-machine with stamped riddles. Both these adaptations are mechanically good, and do credit to the constructor.

Mr. John Caborn, of Denton, Grantham, also exhibited a double-blast winnowing-machine, exceedingly well got up.

Mr. Joshua Cooch, of Harlestone, near Northampton, produced a superior barley-hummeller connected with a winnowing-machine, and supplying itself by an elevator. It is a matter of surprise that this well-known and useful auxiliary, the elevator, is not more frequently applied to barn-work. The power required by it is a mere bagatelle, scarcely indeed appreciable by the man, and it saves much severe labour. A premium of 3*l.* was awarded to Mr. Cooch for this useful combination.

Crushing and Splitting Mills.—Two prizes were adjudged in this class after a minute examination of the numerous specimens exhibited, and the trial of many of them. A premium of 5*l.* was awarded to Mr. James Spencer, of Hopton, near Wirksworth, Derbyshire, for his oat and bean mill; and the silver medal to the Earl of Ducie for a crusher invented by Mr. Richard Clyburn. The first was a remarkably well constructed and effective machine on the horizontal fluted roller principle. Mr. Clyburn's implement consists of two rollers of different diameters having a series of

vertical grooves turned in each of the form of a V, and working into each other. By reason of the difference in velocity given to these rollers a bruising action takes place, and any species of grain is reduced to the desired state of fineness, which can be regulated by approaching or withdrawing the rollers from each other. It is an excellent machine.

Cake Crushers.—A premium of 5*l.* was awarded to Mr. Richard Hornsby, of Grantham, for his conical-pointed, case-hardened, toothed crusher, which had every appearance of being as durable as it proved to be effective on trial.

Chaff-Cutters.—This universally-used implement was produced of all dimensions and powers, whether suitable to the purposes of the smallest stable or the largest farm. A prize of 3*l.* was awarded to Mr. James Smith, of Gloucester, for a chaff-cutter of medium size, power, and price, which possessed, in the opinion of the Judges, very good provision against choking in the feed, as well as the means of regulating the length of cut to great nicety. The same maker also exhibited a combined corn-crusher and chaff-cutter, commendable to those who may prefer one machine to two separate ones.

The powerful chaff-cutters exhibited by the Earl of Ducie and Messrs. Ransome (both of which had undergone considerable improvements since the Bristol meeting) were selected for trial at Mr. White's farm. The former was driven by Mr. Dean's travelling steam-engine, presumed to be exerting a power of from two to three horses, under which circumstances the spiral knife-barrel made about 500 revolutions per minute, and cut at the rate of about 228 bushels of wheat-straw-chaff per hour. Messrs. Ransome's machine was worked by their horse-engine with two horses, the knife-wheel making about 250 revolutions per minute, and cutting at the rate of about 112 bushels per hour. No very nice judgment can, however, be formed of the expenditure of power for the work done when two different agents are employed, as the horse and steam; but it was safe to conclude that Lord Ducie's implement required the least force for equal effect, and was capable of sustaining the velocity given to it without derangement or danger. The spiral knives are also very readily sharpened without removing them from the barrel, and require no fresh adjustments, which are no slight recommendations of the implement. For these reasons the Society's prize of 10*l.* was awarded to the Earl of Ducie.

Messrs. Ransome's machine, which had received valuable improvements (patented by Mr. Charles May, one of their firm), by which its durability is increased, the feeding improved, and the cut rendered cleaner and more effective, merits high commendation and confidence in its use as the best plain knife chaff-cutter yet exhibited.

Corn and Meal Mills.—A large assortment of domestic hand-mills was exhibited by Mr. Alexander Dean, of Birmingham, the grinding parts of which were composed of metallic, French-burr, and grey-stone materials. Mr. Dean's attention to this subject and his good workmanship deserve the encouragement of agriculturists. Several of his mills were applied to the force of small steam-engines as well as horse-power. The Judges were unable to determine between the respective merits of Mr. Dean's metallic and French burr mills, and of a metallic mill recently invented by Mr. Luke Herbert of Dover, exhibited by Messrs. Ransome and other manufacturers. Mr. Graburn has undertaken, at the request of the Council, to submit a specimen of these mills to a lengthened trial in his household, and to report on their respective qualities and performance.

Corn Weighers and Meters.—The silver medal was adjudged to the Earl of Ducie for a self-registering corn-meter invented by Mr. Richard Clyburn. This is a well-contrived and useful instrument, and will be appreciated by feeders of stock, &c., as conducing to exactness of measure, diminishing the chance of robbery, and obviating mistakes of count, as the quantity abstracted from the granary must pass through the machine and be registered on the dials, which are calculated to denote 80 bushels in measures of a quarter of a peck each.

A simple corn-weighing machine was exhibited and invented by Mr. Colville, M.P., but as it was not furnished with a self-registering apparatus, its utility is bounded as compared with the foregoing. Nevertheless, when it is wished to give small determinate weights of grain to animals, in preference to measure, and without regard to a mechanical record of them, this little instrument will be found to answer the purpose.

Turnip Cutters.—A number of these implements appeared in the show-yard, the best of which seemed to partake more or less of the well-known principle introduced by Mr. Gardner. A prize of 2*l.* was awarded to Mr. Thomas Wedlake, of Hornchurch, for a machine provided with extremely simple means for cutting two sizes of slice for beasts and sheep, which is effected by reversing the motion of the cutting-cylinder, and turning over a plate in the feed-box, which directs the roots to one or other side so as to subject them to the action of the different knives fixed on the cylinder.

Root Graters.—Two machines were exhibited for grating turnips and other bulbous roots to a pulp or very small particles, by Mr. E. Moody, of Maiden Bradley, Wilts, and Mr. John Green, jun., of Newtown, Worcester. It is urged by these gentlemen that there is considerable economy in so reducing mangold-wurzel, carrots, and turnips as to mix them more intimately with hay and straw chaff; they assert that cattle eat the mixture more

greedily, and thrive better on it, than when the roots are given separately with the chaff. As the parties were not present, the Judges did not try these implements. They may observe that the practice of grating roots, rather than slicing them, is said to obtain very much in the United States.

Cider Mill.—The silver medal was awarded to Mr. Alexander Dean, of Birmingham, for a new cider-mill manufactured by him, and invented by Mr. James Ashwid, of Bretforton, Worcester-shire. This implement is in fact a crusher or squeezer, being furnished with a piston worked horizontally in a substantial wooden box, from which the apples are discharged in the state of pulp. Mr. Ashwid describes its mode of use and effects as follows:—"I drive it by a one or two horse power used for chaff-cutting, &c., and place it as near the cellar as convenient. It requires two women—one to carry fruit from the heap and throw into the hopper, the other to regulate the feeding with her hands; two men to remove the pulp and press it through haircloths, the same as with the old mills; and one man to carry and tun the cider. The quantity of fruit it is capable of reducing varies, according to its ripeness, from 300 to 400 bushels per day, and produces from 800 to 1000 gallons of juice. Several of my neighbours have already bespoken the use of my mill for the present year who have seen the efficiency of its work and the superior way in which the cider keeps from it. I also tried it last winter for pulping turnips and potatoes for pig-feeding, and found it most economical. The juice is not squeezed out by it, but the pulp is beaten up to about the consistence of paste, which I mix with barley or bean meal, and find the pigs feed much faster than when mixed with water." This new machine was very well got up by Mr. Dean, and accommodated to manual as well as animal or steam power. It has been represented to the Judges that the *grating* of apples is much preferred in America for cider-making to the old rolling-mill; the saccharine matter being much better evolved by grating, and the pips in great measure reduced. This may be worth the attention of cider-mill manufacturers.

Potato Washers.—Mr. Crosskill produced a machine for washing and raising potatoes out of the water, which was deemed to be the best in the exhibition.

Steaming Apparatus.—The Society had called attention to improved steamers for roots. Five sets were exhibited: after examining which a premium of 5*l.* was awarded to Mr. James Richmond, of Salford, for a very complete apparatus, particularly in its fittings, as regards safety, the supply of water, &c. In respect of cost it is moderate.

Feeding Apparatus.—The silver medal was adjudged to Mr. Hill, of Brierley Hill Iron-Works, near Dudley, for his very ex-

cellent iron cow-cribs and sheep-cribs on wheels. His collection also contained numerous other articles of a similar description, which deserve the highest commendation as regards moderate price, lightness, strength, and good workmanship.

A fodder-preserver, more particularly applicable to parks, was exhibited by Mr. James Moorcroft, of Bratley, near Burton-on-Trent, which deserves commendation on account of its neat arrangement, substantial structure, and cheapness.

Weighing Machines.—Mr. H. G. James, Great Tower Street, London, produced two weighing-machines invented by M. George, of Paris, which, on account of the correctness of their principle, were considered to merit the Society's encouragement, and a premium of 10*l.* was awarded for them. It would require more space than can be devoted to this subject to explain the causes of error incident to all weighing-machines hitherto made, and from which Mr. James's are free. The principle is mathematically correct, and mechanically carried out, as is proved by placing the object to be weighed on any part of the scale-board, when it will be found to be balanced by the same weight. Scale-boards of the largest dimension may be used: and it is hoped that by means of this invention agriculturists will be induced to ascertain the relative value of varieties of food in the fattening of cattle, by frequently placing them on the weighing-machine, which will indicate the weight of the largest ox, or loaded cart, with as much accuracy as the sack of corn or still lighter objects.

Fire and Garden Engines.—A number of these eminently useful machines were exhibited. To one hand-engine in particular, invented by Mr. J. Read, Regent Circus, Piccadilly, London, the Judges desire to invite attention, as uniting convenience as respects the garden, with very considerable power in case of fire in dwelling, out houses, &c. With four men it will discharge 20 gallons of water per minute, to a distance of 60 feet, a quantity which may often serve to arrest an incipient fire. The valves are solid and spherical, and may be pronounced as at all times in order for use, so little liable are such valves to get out of repair. It is very light, is moved on two good-sized wheels, and will pass through ordinary doorways. By an arrangement of the levers it is readily reduced to the power of a single man and adapted to horticultural use.

A very powerful pump was applied to Mr. Dean's travelling steam-engine; a combination which may often be found extremely useful for emptying ponds, draining, irrigating, &c., as well as a fire-extinguisher.

Ricks.—The silver medal was given to Mr. John Gillett, of Brailes, near Shipston-on-Stour, for a valuable and cheap little tool termed a rick-ventilator. The very simple idea of boring a

hole perpendicularly into an overheating hay-rick or barley-stack, has been ingeniously carried into practice by the inventor. The contrivance consists of a kind of auger which opens its road with a screwed point, and withdraws a core of hay, &c., leaving a circular hole of 7 inches in diameter. By repeating this operation a hole is quickly pierced to nearly the bottom, but not quite through the rick. The Judges have been informed that the holes thus made remain firm and open, and that the anticipations indulged in the show-yard of the effectiveness of the invention have been fully verified in practice.

A silver medal was also awarded to Mr. George Parsons, of West Lambrook, Somerset, for a mode of raising and depressing a roof over a rick. The roof is constructed of light timber on the truss principle, and covered with some species of impermeable cloth. The rick is made around a post or pillar, having a coarse threaded screw of cast-iron fixed upon it. The centre of the roof is furnished with a nut, so that by turning the roof round it ascends or descends upon the pillar. Much constructive ingenuity was evinced by the author of this contrivance, which is superior in many respects to the common Dutch barn, though it may be found too costly as a fixture in stack-yards.

The Society's offered prize of 20*l.* for the best and cheapest stack-covering was not adjudged.

Field-sundries.—Extensive assortments of iron-fencing, gates, seats, &c., were exhibited. The silver medal was well merited by Mr. Hill, of Brierley Hill Iron-Works, near Dudley, for his wrought-iron farmer's field gates with cast-iron posts, manufactured and sold by him at the low price of 28*s.* These were selected as more especially deserving the notice of agriculturists (in addition to the cow and sheep cribs before mentioned) on account of their remarkable lightness and stiffness, which give assurance of durability. Many other field articles by the same maker, such as hurdles, deer and cattle fencing, &c., were constructed with equal attention to strength and moderate cost.

A silver medal was awarded to Mr. C. R. Colville, M.P., of Lullington, near Burton-on-Trent, for his invention of a useful wrought-iron wheelbarrow, arranged with a furnace and melting-pot, to transport gas-tar for paying over palings, &c.

Mr. Joseph Hall, of Cambridge, produced a new tool called a weed and bush extractor, which is an ingenious combination of the lever with a gripper for drawing out tap-rooted weeds, or stocking up fences. The implement is handy in use, and adapted both in strength and price to the object for which it may be required. The silver medal was given to Mr. Hall for this invention.

Waggons, Carts, &c.—Four premiums were adjudged to exhibitors in this department, and though the show-yard contained

specimens of vehicles which had partaken but little of modern improvement, no previous exhibition approached the present either in the variety or excellence of many of the carriages adapted to the numerous uses of the agriculturist. Amongst the builders of these implements Mr. Richard Stratton, of Bristol, shines conspicuously.

To him the Society's prize of 20*l.* was awarded for his spring-waggon on the equirota! cross-lock principle, referred to in the Bristol report. On the present occasion it was improved in its details, mounted on springs, and furnished with Thatcher's breaks. It will be understood that the fore-wheels are of the same size as the hind ones, which must considerably diminish the draught. It had a pole, driving-seat, foot-board, and patent axles. Mr. Stratton estimates the saving in draught arising from springs as equal to 30 or 35 per cent., in which opinion he is borne out by well-known experiments. This waggon turns in a sufficiently small space; and the adapting such a carriage to the general purposes of road and field does the highest credit to Mr. Stratton as a builder and mechanic. In price it did not exceed that attached to several ancient clumsy waggons exhibited.

The same maker also produced a variety of other waggons, as well as single-horse carts on springs, applicable to general or more special uses; and the Judges have to notice with high commendation a market and family cart on springs, the arrangements and finish of which were of the first style of workmanship. The observation, however, may be made that some small deduction from the comforts of this vehicle may be advisedly spared in order to reduce it safely below the duty price.

The silver medal was adjudged to Mr. Stratton for a low manure tipping-cart, with a liquid-manure cistern body to fit. This cart combines a number of excellent properties. The cranked axles so reduce the height of the cart-chest from the ground as greatly to diminish the labour of filling. The chest tips upon the line of the axles, which is the only true place for effecting that operation; and it is retained in place by a spring-catch, or adjusted to any angle for discharging, in the simplest and safest manner. The liquid-manure body is 5 feet long, by 3 feet 3 inches wide, and 20 inches deep, containing about 169 gallons, or about 15 cwt.; which, with the weight of the body, pump, &c., brings the whole to about 23 cwt., and therefore within the power of a single horse. The removal of one body and affixing the other is performed with the greatest ease by one man. This adaptation of solid and liquid manure bodies to the same wheels, axles, and shafts, is strongly recommended to the attention of agriculturists.

Mr. Daniel Coombes, of Shipton, near Burford, Oxon, introduced a novelty, by rendering two single-horse carts convertible

into a waggon, so that the purchaser of the former may have a waggon at his disposal, as his preference may dictate. The combination or separation of these carts is accomplished very quickly, and by simple means; and it was considered that the inventor well merited the encouragement of 5*l.* awarded to him. It requires some experience to ascertain whether the carts so joined have the requisite strength in the centre, when loaded as a waggon; and also whether the place of junction be sufficiently strong to resist the lateral strain thrown on that part when the fore-wheels turn, and the hind-wheels are fixed. Having, however, overcome so much, Mr. Coombes may see his way in remedying any defects which time may render apparent.

A premium of 10*l.* was adjudged to Mr. A. White, of Old Sleaford, Lincolnshire, for his spring carriage for the carrying of linseed-cake, delivering corn, and other uses. This vehicle was furnished with a pole and driving seat; it had a well-closed cover removable at will; and side-rails for converting it into a harvest-waggon. Its usefulness would also be found for numerous other purposes in a farmer's establishment.

A gig-cart, exhibited by the Rev. Thomas Sewell, of Nether Broughton, near Melton-Mowbray, and built by Mr. Thomas Dutt, of Bungay, Suffolk, is entitled to high commendation as uniting peculiar comfort and accommodation, whether for family use, or the transport of luggage, &c. It was designed and finished in a superior style, and its price under duty.

It is a pleasing task to have to record such rapid improvement in the construction of implements so indispensable to the agriculturist as those of which the horse will probably ever continue to be the prime mover. The economy of his force is so much diminished expense to his employer. It was noticed in the report of last year's exhibition that "the show-yard did not furnish a single specimen of a waggon or cart on springs." On this occasion no less than 15 out of 38 of the vehicles exhibited were furnished with them, proving that the Society has only to indicate a want, and that machine-makers are able and ready to supply it.

Carriage Drags or Breaks.—The silver medal was given to Mr. Charles Thatcher, of Midsomer Norton, near Bath, for his patent self-regulating self-acting breaks, applicable to carts, waggons, and vehicles of all descriptions. This invention was rewarded at the Bristol Meeting, and described in that report, since which time it has been materially improved by doubling the force of the horse's pressure on the wheel-nave, and therefore increasing his confidence in descending hills. The Judges took the opportunity of testing its powers, and the sagacity of the horse in trusting to them, by causing a cart furnished with these breaks, and heavily laden with implements, returning from Rough Heanor to

Derby, to be turned up a steep bank adjoining the road. The horse was then encouraged to descend by the voice of his driver, having never before felt the breaks. After a slight hesitation, and a few experimental steps, the animal seemed to acknowledge his power of holding the load, and came down the bank as steadily as if he were drawing on a level. Coaches have also been fitted with this simple apparatus, and the Judges understand that the strangest horse unhesitatingly avails himself of it, and regulates his resisting force with remarkable delicacy, according to the greater or less degree of the declivity.

Cart Wheels and Tires.—Several manufacturers exhibited sets of wheels and axles, for one of which, by Mr. Crosskill, of Beverley, the silver medal was awarded, as combining good workmanship with cheapness.

The Judges have also to commend the $4\frac{1}{2}$ inch ridged tires applied by Mr. George Coates, of Richmond, Yorkshire, to some well-made carts exhibited by him. These were rolled in a piece, and made an excellent job.

Harness and Gearing.—With respect to harness no improvement of moment was brought to the observation of the Judges.

Under the head of *gearing*, which includes the methods of connecting or coupling animals with the objects to be put in motion, Messrs. Ransome produced some new patent iron-trussed whippetrees, remarkable for their simplicity, strength, and durable properties. For this invention the silver medal was adjudged. The following figures will at once convey a clear idea of the structure of these whippetrees, which are altogether composed of light wrought-iron. Fig. 1 exhibits them as connected for a pair of horses; fig. 2 shows the truss in the centre; and fig. 3 is a section through the centre, to a scale of half the full size, representing the form and substance of the bows or stretchers, which are welded together at the extremities, leaving an eye for a ring or hook. By this arrangement immense strength is derived from light materials, and many delays and accidents, which attend the fracture of the wooden articles in general use, will be avoided by employing these metallic dragging-bars.

Fig. 1.

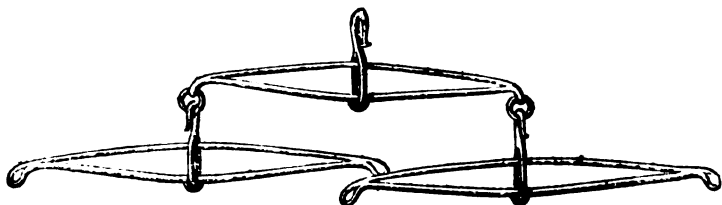


Fig. 2.

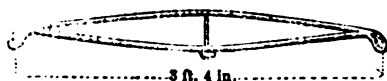
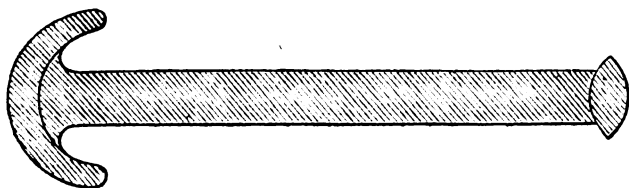


Fig. 3.



Dairy Implements.—Various churns were exhibited both of the upright and barrel construction, and having different motions. The Society's prize of 5*l.* was given to Mr. William Wood, of Knutsford, Cheshire, for the adaptation of a rotative movement to work an upright churn. It was ingeniously and conveniently managed so as to accommodate a female in the sitting posture.

Six cheese-presses claimed attention, and two premiums of 3*l.* each were awarded; one of them to Mr. James Smith, of Gloucester, for a single press, and the other to Mr. Richard Stratton, of Bristol, for a double press, invented by Mr. W. James Gingell. The first of these was furnished with a convenient and excellent pressing power, combining the continuous action of the lever with that of a screw to elevate it as required, so that the weight has never to be released in order to raise the lever. Cleanliness is also ensured by furnishing the screw-handles with wooden hafts, in order to prevent the dairywoman's hands from touching iron, which is represented to be a matter of no slight importance. Mr. Gingell's double press is on the same lever principle as his single one rewarded at Bristol, but better constructed, and is a very neat, compact machine. The Judges, however, are disposed to consider the compound screw and lever principle, as arranged by Mr. Smith, to possess advantages over any pressing power yet exhibited. This plan may possibly be made applicable to the double press through the medium of one screw, which would diminish the cost, and is a matter worth the consideration of the inventor.

Dynamometer.—A dynamometer on a new construction, invented by Mr. Clyburn, was exhibited by the Earl of Ducie. This instrument purported to possess new and valuable properties, and has been referred by the Council, together with Messrs. Cottam and Hallen's instruments, to a future and more correct

trial than either time or the condition of the land permitted at the meeting. The charge of comparing and reporting on their respective merits has been undertaken by the Duke of Richmond, Captain Spencer, and Mr. Jaques, who will use them in succession.

Model Map.—The silver medal was awarded to Mr. John Bailey Denton, of Southampton, for a highly ingenious and well executed map in relief, showing the superficial variations, water-courses, levels, &c., of an estate or district. An ordinary paper map can only represent truly a flat superficies; and, however well it may be executed and shaded, such a map cannot convey to the mind any correct idea of undulations, depths of water-courses, relative levels, or the general configuration of the country. Neither are sections of much aid in enabling a landed proprietor to seize and retain in his memory a correct image of all those terrestrial phenomena by which many of his agricultural operations must be, and are in reality, governed. The multiplicity of sections requisite to denote such data at a glance would only tend to confuse. It has been Mr. Denton's object, in contriving the raised map submitted to the Society, to place under the eye an exact miniature model of a farm, estate, or district, so that it shall represent the minutest difference in level, and carry on its surface a pictorial *fac simile* of its character. He has succeeded in giving to the surface a coating which renders his model map impervious to water; and he represents it as proof against shrinking, cracking, or warping. In fact, it carries water when poured upon it, by means of which and of simple accompanying instruments, the discovery of every hydraulic fact, as touching outfalls, the proper courses for drains, the capability of distributing water collected by drainage, or of employing it as power for farm uses—as has been so skilfully accomplished by Lord Hatherton—will be greatly facilitated. The surface is coloured in oils, and therefore admits of its displaying a picture of the particular use or culture to which the various divisions of an estate or farm may, at any time, be appropriated; and a simple method is applied of recording the geological stratification as ascertained by boring. Mr. Denton states the price of completing these maps at from 2s. 6d. to 3s. 6d. per acre. In awarding the Society's silver medal for this invention, the Judges have looked at it not as a mere ornament or toy, but as an useful auxiliary to the agriculturist, by assisting him in the record, study, and full comprehension of the phenomena of that surface and subsoil upon which his art and capital are expended.

Drainer's Level.—An instrument for assisting workmen in giving an uniform fall to drains was exhibited by the inventor,

Mr. A. Notman, of Painswick, Gloucestershire, and rewarded with the silver medal. It is simple, convenient, and possesses the requisite properties to ensure accuracy. The use of levels is chiefly required by workmen habituated to drainage where the fall is but slight, and the length of cut great. In such localities extreme exactness may be obtained by means of Mr. Notman's level, and it is used with the facility which the nature of the work demands.

Domestic Articles.—The principal object worthy of note, besides the hand-flour mills already mentioned, was a barrel thrawl, or stillion, of cast-iron, furnished with a very simple and effective lever apparatus for tilting casks without shaking their contents. It is the invention of Mr. William Hutchinson, of Derby, to whom a premium of 2*l.* was awarded for this commodious and durable piece of cellar furniture.

Messrs. Cottam and Hallen exhibited Mr. Carson's patent syringe for salting and curing meat, which merits trial in families, as it is said to afford a more speedy and efficacious method of impregnating the internal parts of flesh with the intended pickle than can be effected by steeping the mass in liquid, or covering it with salt. It is averred that meat thus treated may be cooked the same day, and will be found to be uniformly and perfectly prepared.

Award of the Gold Medal.—In concluding their notice of this immense and splendid show of agricultural machinery, the Judges have to record the estimation in which they held the constructive skill and admirable workmanship displayed by Messrs. Ransome, of Ipswich. The Society's gold medal was awarded to these mechanicians as an acknowledgment justly due to the merit of their varied collection.

JOSIAH PARKES.

R. S. GRABURN.

GEO. LEGARD.

XXXVI.—*On the Food of Plants.* By Dr. FOWNES.

PRIZE ESSAY.

[It may be proper to remark that although circumstances have prevented the publication of this Essay until the present time, it was written in the month of February, 1842, and the prize adjudged in the following December. No alterations of any importance have since been made.—GEO. FOWNES.]

THE subjects proposed by the Society for discussion are the following :—

1. The sources from which plants derive the elements of which they are composed.
2. The mode in which farmyard dung strengthens the growth of agricultural crops.
3. The mode in which other manures, either singly or combined, act on vegetation.

It is obvious that the answer to the first of these questions must afford the key to the solution of the others.

The inquiry very naturally divides itself into the following sections :—

1. The history of soils, their origin and chemical nature.
2. The structure and composition of plants, more especially the latter; and
3. The nature of the materials furnished to them as food by the earth and the atmosphere, and the modifications of these supplies by the agency of man.

The Origin and Composition of Soils.

The hard and rugged granite rock; the black and shapeless masses, the residue of the fiery torrents of melted matter which still occasionally pour from the volcanic vents yet existing in many parts of the world; the still more refractory limestone; all, after a certain and very variable lapse of time, undergo a change which, commencing at the surface and travelling inwards, gradually covers them with a pulverulent or sandy matter, retentive of moisture, and capable of receiving the roots of plants and ministering to their existence. This process is called “disintegration,” and is one partly chemical, partly mechanical. The solvent powers of water, more especially when charged with carbonic acid, which always happens to a greater or less extent; the excretions from the roots of the first coming plants themselves; the expansion of water by freezing; the insinuation of the rootlets of plants into the crevices so formed, and their subsequent enlargement, are probably the chief agencies directed to this end, and the result of the whole is the production of a soil, whose depth will be principally dependent on two circumstances, viz. the nature of the rock, and the length of time during which this

process has been going on. Such is the general principle; it is necessary, however, to be more explicit.

Soils are usually described as either purely argillaceous, calcareous, or sandy, or else as having a mixed character: thus, when clay and sand are both present in considerable quantity, the term "loam" is applied; a mixture of clay and carbonate of lime is called a "marl," &c. These words are exceedingly indefinite, and their uncertain use frequently leads to error; indeed a good system of classification of soils, founded principally on their chemical constitution, would be a great boon to scientific agriculture.

1. Clay is derived primarily from the decomposition of an unstratified rock, and as this generally contains a very large proportion of felspar, that substance may be looked upon as the principal source of the body in question. It is no argument against this view that many beds of ancient clay exist among the secondary strata, and occasionally form the surface of the ground, and consequently the soil itself; there is every reason to believe that these beds owe their origin to the destruction of very far more ancient masses of granite, or trachyte, or basalt, the ruins of which were transported by water to the bed of some then existing sea and there deposited.

Beside these clay strata belonging to the secondary or middle series, must be placed the still more ancient formations of slate, frequently of immense thickness, and so altered by the gradual but ceaseless effects of ever-acting causes, that their origin is sometimes lost sight of: still there is no difficulty in tracing the change from the softest clay to the most compact slate.

The disintegration of granite has been studied with considerable success. The felspar which it so largely contains is so constituted that it may be looked upon as a double salt of alumina and potash, analogous to common alum, having silicic acid, or silica, in the place of sulphuric.

Alum, anhydrous . . . $\text{K O, S O}_4 + \text{Al}_2 \text{O}_3, 3 \text{ S O}_4.$

Felspar $\text{K O, Si O}_2 + \text{Al}_2 \text{O}_3, 3 \text{ Si O}_2.$

When this substance is exposed to the action of water charged with carbonic acid, it slowly suffers decomposition in such a manner that the greater part of its alkali is removed together with some silica, in a soluble condition, while all the alumina with the rest of the silica and a little potash remain behind under the form of clay. This decomposition is sometimes accelerated by the formation of sulphuric acid from the iron pyrites so frequently present.*

In certain districts of Cornwall and Devonshire, as well as in

* Mitscherlich, Lehrbuch, vol. ii. p. 157.

other places on the continent of Europe and in the East, where granite is exposed at the surface, the progress of this decomposition can be distinctly traced from the sound, unaltered felspar with its brilliant cleavage, to the dull earthy mass, so soft as to be cut with the utmost ease, although still showing its peculiar structure and the form of the crystals contained in it. It is from this source that all the fine white clay used in the manufacture of porcelain is obtained, by simply crushing the decomposed granite to powder and washing it over in a stream of water, whereby the coarser and heavier portions, the quartz and the mica, are separated.

Subjoined is the composition of one of the most celebrated clays of this description, which may be taken as an excellent type of the substance itself in its present form, namely, that employed in the Sèvres porcelain works :—

Silica	48·8
Alumina	37·3
Potash	2·5
Water	11·4
	<hr/>
	100·0

The red and yellow clays of the secondary strata, which are alone of importance in connexion with agriculture, differ from that above described in containing a very much larger proportion of silica, not as sand, but in an impalpable state, in intimate union with the other constituents, and a large quantity of oxide of iron. The latter sometimes equals and even surpasses in amount the alumina, and has probably been derived from the decomposition of hornblende or augite—minerals rich in oxide of iron, and abundantly contained in basaltic rocks.

It must not be supposed that anything like a pure clay, even of the last kind, is ever the subject of tillage: the heaviest and stiffest clay soil contains probably, in most cases at least, half its weight of sandy matter, chiefly siliceous, easily separable by the process of washing; it is very surprising, indeed, how small a proportion of alumina suffices to confer great plasticity on such a substance. The most remarkable circumstance connected with such soils is the quantity of potash they appear to contain in an insoluble state, as one of the silicates of that base. In a soil of the kind mentioned, a stiff deep-red clay from one of the midland counties, the finely divided matter got by washing contained above 3½ per cent. of potash in this condition, a thing quite unlooked for. We have reason to think that this potash plays a very important part in the nutrition of plants, and that the insoluble state is by no means without its use.

2. *Calcareous Soils.*—These are derived from the disintegration

of limestone of various kinds, and in some particular localities from coral rocks, which we cannot regard otherwise than as incipient limestone formations, inasmuch as many of our older beds of that substance have certainly had such an origin, as their organic remains testify.

Limestones differ very much indeed in their power of resisting disintegration: some, such as the hard blue mountain limestone beneath the coal-beds, resist more effectually than the hardest granite; and districts formed of this material are distinguishable, even at a distance, by the scantiness and poverty of their vegetable covering, while, on the other hand, the softer beds, such as the oolites and the chalk, give way much more readily and furnish tolerably fertile land. The mode in which the naked coral reefs of the Pacific become in time clothed with vegetation, has been a favourite subject with voyagers in those parts; they describe to us how the seeds of plants which are unaffected by salt-water, such as cocoa-nuts, get carried by the waves from place to place until they are ultimately thrown high and dry into some crevice on the top of the reef, already in a slightly disintegrating condition; how other seeds are brought by birds, and so forth, until at length the rock becomes covered with verdure: a lodgment being as it were thus made, the vegetable invaders acquire stronger and stronger hold, until at length a soil has been formed capable of supporting all the ordinary productions of the climate.

3. Sand is produced by natural operations in two ways.—When disintegrated felspathic rock is exposed to the natural elutriation of a stream of water, the materials of which it is composed are carried onwards by the stream to very different distances: a slight diminution in the current causes the deposition of the quartz grains, &c., while the finely divided clay is conveyed much further, and only settles down when the water is tranquil: now sand of this description is recognised by the angular character of its grains—they are irregular quartz crystals in point of fact.

The mechanical attrition of water is, however, by far the most abundant source of this substance. All ordinary sand, when examined by a magnifying-glass, sufficiently points out by the smooth rounded aspect of its grains its origin in the abrasion resulting from the rubbing of masses of stone against each other by the action of water in motion. A glance at what is constantly going on at every sea-beach and in every water-course will set this matter at rest. The nature of the sand will, of course, depend upon that of the rock from which it is derived; and thus we may have it siliceous, as in all ordinary cases; calcareous, as on the beach of a coral island; micaceous, &c.

A large proportion of the earth's surface is covered with various irregular beds of sand, gravel, and clayey matters, which have

been brought from a distance and scattered about by the violent, although apparently transient, action of water: it is usual to apply to these the general name of "alluvium." We have no difficulty in tracing to this disturbance of the surface the origin of the numerous mixed soils, whose fertility and value so far exceed those of the purer kinds. We owe also to the decomposition of some varieties of lava, mixed soils of extraordinary productiveness, arising in a great measure from the quantity of alkaline salt they contain; the neighbourhood of Naples and many other localities will furnish examples. It is not impossible that some of the effect produced is to be attributed to a remnant of the original heat in the interior, as such a mass of badly-conducting matter will cool with extreme slowness when the temperature to some depth approaches that of the air.

Every soil in which plants have once grown contains more or less of a blackish or brown substance, called "humus," or vegetable mould. This substance certainly plays an important part in furnishing food to plants, although perhaps not exactly that which has usually been assigned to it.

Liebig has taken great pains to show that this humus is a substance of very uncertain composition; it is in short nothing more than the woody fibre of previously existing plants in a state of slow combustion by the oxygen of the air, which continually finds its way through the porous soil, slowly and constantly giving off carbonic acid and water, until at length nothing is left but a little black coaly matter, almost incapable of further change.

This humus, a substance thus incessantly changing in composition as its decay advances, has been confounded with certain products of the action of alkalis and acids on sugar and woody fibre, which resemble it somewhat in physical characters, but which seem to be really definite substances, consisting of carbon and the elements of water. It is pretty clear, however, that the bodies in question belong to a different class, and have no immediate connexion with the organic matter of the soil.

The humus of the soil is not sensibly soluble in cold water; of this Liebig has adduced sufficient proof. Boiling water takes up a minute quantity and acquires a yellowish tint, but it is very possible that in this case some chemical change has occurred by the action of the boiling liquid. When heated with dilute solution of alkali it is readily acted on, furnishing a deep brown liquid from which acids precipitate a brown flocculent matter, soluble in about 2500 parts of water, to which the name "humic" or "ulmic acid" has been given. It must be distinctly understood that we have no reason to think that anything like humic acid ever exists in ordinary soil; it is only formed by the action of alkalis on the decomposing vegetable matter.

The amount of humus present in different lands varies very greatly; from the loose blown sand of the "dunes" by the sea-side, to peat-earth, of which it forms the principal constituent.

The fertility of a soil is dependent on other things besides its chemical composition; we must consider that the office it performs is twofold, namely, to retain the plant firmly in the position most favourable to its growth, and to supply a certain amount of food: hence mechanical texture becomes a matter of great importance; it must be firm enough to afford the proper degree of support, and at the same time loose enough to allow the delicate fibres of the rootlets to extend themselves, and also access of air to take place, without which the plant cannot live; it must be of such a texture as to retain for a considerable period the water which falls on it, and at the same time porous enough to suffer the excess to drain away, otherwise the roots of the plant will rot; it is for these reasons that the nature of the solid substratum at some depth beneath the soil must be borne in mind: these, and many other things, such for example as the condition of the surface with respect to its absorbent power for heat, all tend greatly to complicate the subject, and render decisions concerning the comparative value of different lands founded on merely chemical evidence exceedingly prone to error.

The Composition of Plants.

When speaking of the composition of any substance, chemists are in the habit of drawing a distinction between what are termed its "proximate" and its "ultimate" constituents. For example, the salt called acetate of morphia is considered to be composed of two different bodies of opposite chemical energies, namely, acetic acid and the organic base morphia; but both these are themselves compound; the first contains carbon, hydrogen, and oxygen, and the second, these elements with the addition of a fourth, nitrogen; we call therefore the acetic acid and the morphia the proximate, and the carbon, hydrogen, oxygen, and nitrogen, the ultimate, elements of the salt in question. Just in the same manner the juice of a plant may contain a number of proximate principles, gum, sugar, albumen, &c., and its solid tissue may be made up of others, such as lignin, starch, &c., all being themselves compounds of a very few simple ultimate elements.

Now, these ultimate elements are not numerous; the most important are the four mentioned above, and of these all the strictly organic portions of the plant are composed, however much these latter may differ in properties. Other substances are also present in smaller proportions, such as ammoniacal salts, silica, sulphuric and phosphoric acids in combination with lime, magnesia, traces of oxides of iron and manganese, &c. Some of

these bodies seem to be essential constituents of the plant; others are accidental and variable. We shall have to discuss these matters at length further on.

The proximate vegetable principles may be divided into two great sections, namely, what may be called special products of certain particular plants, and sometimes of particular organs and general products of vegetable life, or those substances which are always present in every plant, and together make up the great bulk of the solid portion of its substance. To the first class belong the vegeto-alkalis, morphia, cinchonia, quina, &c.; peculiar colouring matters, such as the red dye of madder, the body which on contact with air produces indigo, &c. These substances usually occur in very minute quantities, and although exceedingly interesting in many important relations, do not require extended notice in a paper of the present kind.

Not so, however, with the second group, the members of which demand our close and attentive study if we wish to extend our knowledge of the phenomena of vegetable life.

The bodies in question allow of easy and natural division into four classes, namely, neutral substances, vegetable acids, oils and resins, and albuminous matters; those last mentioned alone contain nitrogen.

The most important of the first class are sugar, starch, gum, and lignin, or woody fibre. The chemical history of these substances is highly interesting; the curious transformations they may be made to undergo even by the artificial processes of the laboratory, and the great importance of some of them as articles of food to man and animals, concur in rendering their study one of the most engaging portions of organic chemistry. The composition of these principles is also very remarkable; they all consist of carbon, hydrogen, and oxygen, the two latter being always in the proportion to form water—hydrates of carbon they have been called, but without a shadow of reason that such is their real constitution: they differ considerably in their physical characters, some being soluble, others not, some sapid, others tasteless. The name "indifferent," or "neutral," is given to them on account of the little tendency they possess to enter into chemical union with other substances, and is convenient, although not rigidly true, inasmuch as most of them can be made to combine with such bodies as lime and baryta and oxide of lead.

Of these neutral principles, lignin, or woody fibre, and starch deserve the most attention; the first by reason of its abundance in all plants, constituting as it does the great bulk of the solid woody matter, and the second on account of its extraordinary structure, which forms as it were a connecting link between strictly organised bodies and those which are crystallizable; that

is, merely subject to the laws which govern ordinary molecular actions.

Starch is found abundantly in nearly all the tissues of plants; stem, leaves, roots, seeds are occasionally charged with it almost, in appearance, to bursting; it is only necessary to instance the common potato, grain of all kinds, the roots of the orchis and arum, as examples. When these are torn to pieces by grating and placed in a little trickling stream of water, the starch is washed out of the cellular tissue which contained it, and on the water being allowed to stand, settles down as a white silky powder, which under a lens exhibits the appearance of rounded, transparent, colourless granules, the magnitude of which varies very much with the plant from which they were obtained.

Different microscopic observers by no means agree concerning the intimate structure of these granules: some put them down for little membranous bladders filled with transparent viscid liquid, while others think they have seen enough to convince them that the little bodies in question are composed of concentric layers of solid gummy matter, covered on the outside by a kind of skin impermeable to water: all seem to agree, however, about the membranous covering.

When starch is put into cold water, and the temperature gradually raised to the boiling point, this membrane gives way as if by the expansion of the matter within, solution takes place, and a translucent jelly, familiar in the case of common arrow-root, is produced. This change once effected, it is easy to understand that a return of the starch to its former *organized* condition is impossible.

If to gelatinous starch we add a little dilute sulphuric acid, and boil the whole for a few minutes, the mixture becomes limpid as water, and in that state is found to contain a peculiar gummy matter called "dextrine," an isomeric* modification of gelatinous starch. If, however, the ebullition be continued for a longer period, the new substance undergoes further change, and passes into sugar of the variety contained in fruits. During this action the sulphuric acid undergoes no change, nothing is taken up from the air, and no gaseous matter given off.

When grain is made to germinate, barley for example in malting, a part of the insoluble starch passes into sugar, and at the same time a peculiar principle called "diastase" is generated from the azotized matter of the grain. This diastase has the remarkable property of occasioning, when present in very small quantity, the conversion of starch into grape sugar at all temperatures, from that of ice to near the boiling point of water. Hence,

* Same composition reckoned to 100 parts.

there is no difficulty in understanding the production of sugar in germination.

The function known to be performed by starch in the vegetable kingdom is one of extreme importance.

The great event in the life of every plant is the fertilization and subsequent development and ripening of its seeds, and to this end the whole energies of the plant are directed from the very commencement of its being. Up to the time of flowering, provision is being made against the extraordinary demand for nourishment by the young ovules, and this provision is effected by the production of insoluble starch out of the then abundant sweet and gummy juices of the plant, which is stored away in the cells of its tissue, until such time as its presence is required to feed the ovule, when it is again converted into soluble matter, and conveyed to the spot where it is wanted. Arrived there, a large proportion of it is reconverted into starch, and laid up within the integuments of the seed, once more to pass into the soluble condition, when the time for the development of the embryo shall come.

The starch of a plant has been compared to the fat of an animal: a sort of reserved fund of nutritious matter laid up in times of plenty to guard against the destruction which must ensue when the demand for assimilated food, for vegetable blood, greatly exceeds the capacity of the organization to furnish. We must be careful not to push the parallel to any extent, since, according to views now held by those most competent to judge, the great use of animal fat is to supply fuel to a kind of combustion at the expense of the oxygen of the air, which goes on, not in the lungs, but in the minute circulating vessels, and the end of which is the production of animal heat.

It is obvious that in the phenomena discussed, one-half only of the process is intelligible to us, namely, the passage from the insoluble to the soluble state; we cannot doubt that this is due to the agency of diastase, or some such substance; but how to account for the opposite change? We must still have recourse for the present at least to some occult vital principle.

It is probable that the formation of woody fibre occurs much in the same manner out of the semi-fluid substance (cambium) found beneath the bark of a tree in active vegetation. We can, by a particular process, convert this lignin into gum and sugar: the reverse change is beyond our power; but the operations of nature, even on the supposition that the change is purely chemical, are not limited to our imperfect methods of proceeding.

Vegetable Acids.—These are found in the juices of all plants, usually in a state of combination with potash, soda, ammonia, or some of the earths, which remain behind (except ammonia) after the destruction of the plant by fire in the state of carbonates.

The most important of these are the tartaric, citric, and malic. We know little or nothing concerning the office performed by these acids.

The composition of the three acids mentioned is such that they contain an excess of oxygen over that required to form water with their hydrogen, and to this excess the character of acidity has been attributed. This can hardly be true, since two of the most powerful among organic acids, the acetic and the lactic, contain oxygen and hydrogen in the relation to form water.

Oily and Resinous Principles.—Frequently found in special vessels, like enlarged cells, in particular parts of the plant. Sometimes they form a waxy varnish to the leaves, and sometimes occur in large quantities in the seeds.

Oils are divided into Volatile, or those which distil over unchanged, and Fixed, or such as undergo partial decomposition when the attempt is made to convert them into vapour. The former have generally a powerful taste and smell, which is not the case with the latter. Some of the volatile oils, such as those of turpentine and lemon-peel, contain no oxygen; they are carburets of hydrogen, and present interesting cases of isomerism.

Resins are looked upon as products of the gradual oxidation of volatile oils, with which they are always associated in nature. Altogether these matters are too purely chemical to require discussion in the present case.

Azotized Principles, Albuminous Matters.—These substances are exceedingly important, but it is only very lately that this importance has been placed in its proper light by the discovery made by the illustrious Liebig of the absolute identity of some at least of these bodies with the so-called proximate constituents of the animal frame, albumen, fibrin, and casein. This is no conjecture; it is established by the most unequivocal chemical evidence: the origin of these substances is to be sought in the plant on which the animal feeds; arrived in his stomach, they undergo simple solution in a peculiar manner, and are then directly absorbed into his system.

Albumen in an uncoagulated state is found in most vegetable juices: when these are boiled, the albumen becomes insoluble and separates. The substance called "gluten," which remains when dough of wheaten flour is kneaded in a stream of water, whereby the starch and soluble matters are washed away, and which forms so important a constituent of wheat as an article of food, consists chiefly of a mixture of two substances, differing in properties, but having the same composition, one of which is identical with the fibrin of the blood. The other has not been thoroughly examined.

Beans, and many other seeds which contain oil, such as almonds, besides albumen, are loaded with a substance quite indistinguish-

able from the casein of animal milk by any means physical or chemical, and still more strange to say, apparently in the same state of combination, and associated with the same inorganic substances, as in milk itself.*

As may be imagined from such a statement, the proportion of gluten in the different kinds of grain and for food will determine, to a great extent at least, their relative nutritious values. We shall see hereafter that this proportion varies considerably in the same grain grown under different circumstances, so that the study of these things has a direct and immediate bearing on the practice of agriculture.

With respect to the inorganic constituents of plants. From the comparatively small quantity in which these matters occur, they have usually been regarded as adventitious, and accordingly neglected. We have reason to reject this idea, at least with regard to many of them; Liebig has taken pains to show, principally by the analyses of the ashes of certain woods made by M. Berthier, of the *Ecole des Mines*, that a certain number of inorganic matters, in particular quantities, are essential to the well-being of a plant; and that although variations among them occur, they take place in a regular manner and according to a fixed law. Many of the now old ash-analyses of De Saussure lead to the same conclusion, which is also borne out by my own experiments described in the latter part of this essay.

The subject of vegetable structure and physiology is so extensive and so complicated, and withal so little understood, that anything like an attempt at description of what is known of the anatomy and living functions of plants would be out of place. The following slight notice must suffice.

In examining a plant, even from among those highest in the scale, we cannot avoid being struck by two things; the total absence of anything like the circulatory arrangement of the higher animals, and the want of a nervous system. It is no argument against this to bring forward the case of the numerous tubes which are found in some plants, formed, as is thought, of a membrane having a spiral fibre within, as these are admitted to terminate after a short course, and are never known to anastomose. The recently seen "vessels of the latex" also are too obscure and too little known to form a good exception. With respect to nervous energy, something like this seems to exist in the well-known sensitive plant: it is not contended that plants are entirely destitute of something of the kind, as the curious and opposite effects of narcotic and irritant poisons on them serve to show, and which indeed seems to be involved in the very idea of life of any de-

* *Annalen der Pharmacie*, 39—143.

scription, but simply, that in vegetables no nervous centres are known to exist, but the power, if present at all, is diffused throughout the whole substance of the plant. In fact, these beings seem to possess a kind of "cellular life," and this uniformity of structure is such, that almost any one part may be made, by very slight modification, capable of doing the duty of another.

It is a very old idea to compare a living plant or animal to a chemical laboratory, in the different parts of which various processes are constantly going on, partly chemical in their nature, but modified by the agency of that mysterious principle, life. We have no reason to take a different view of the subject; the discoveries of modern chemistry tend to confirm it; we see inorganic bodies of simple constitution, such as water and carbonic acid and ammonia, enter the plant, and there become converted into such complicated substances as sugar and starch and albumen, in virtue of powers and agencies with which we have little or no acquaintance. To decompose carbonic acid and set free its carbon requires in our hands the exertion of the most intense chemical energies, such as the action of potassium at a high temperature; yet the green plant, under the influence of sunshine, effects this with the utmost apparent ease. Nevertheless, I am very far from thinking that we shall never know more of these things than we do at present; indeed recent discoveries respecting the phenomena of fermentation hold out some prospect of ultimately obtaining a key to a portion of this magnificent chemistry of nature.

The Food of Plants.

The chemical history of the most important among the proximate vegetable principles having been thus shortly discussed, we are now in a condition to grapple with the far more difficult question of the source or sources from whence the plant has derived the elements of which these principles are composed; in a word, the food upon which plants subsist. Is this food derived from the earth, or from the air, or from both? And if the latter supposition be true, what share does each contribute towards the effect observed?

The atmosphere which surrounds the earth, and which extends with a rapidly diminishing density to a height of about 45 miles from its surface, consists of a mixture of oxygen and nitrogen gases in the proportion by measure of 21 volumes of oxygen to 79 volumes of nitrogen,* and further, these proportions are quite

* More correctly, according to the recent elaborate researches of Dumas, 20.8 meas. oxygen to 79.2 meas. nitrogen. (*Annales de Chimie et de Physique*, Novembre, 1841.) In addition to the substances above enumerated, it is proper to observe that an opinion is held by some that the air

constant and invariable in every part of the atmosphere, high or low. Uniformity of mixture is attained and preserved by that singular law affecting the constitution of gases in general, called the "law of diffusion," first discovered by Dalton, and since so ably investigated by Professor Graham.

In addition to these essential constituents, the air contains diffused through it at all times a certain amount of carbonic acid, a quantity of aqueous vapour depending very much upon its temperature, and finally, a very small but unequivocal trace of ammonia. The proportion of carbonic acid present has been made the subject of careful investigation; according to the best experiments we have, those of De Saussure, 10,000 volumes of air contain a quantity of that gas varying from 6.2 volumes, the maximum, to 3.7 volumes, the minimum; $\frac{1}{1000}$ ths or $\frac{1}{1000}$ ths may be assumed as a sufficient approximation to a mean state. Within the limits mentioned the proportion varies with the season, the day and night, difference of elevation in the air, and perhaps other circumstances. It is essential to a proper understanding of the question considered that these facts be carefully borne in mind.

We have to account for the carbon, hydrogen, oxygen, and nitrogen so abundantly contained in every plant; the origin of the inorganic substances present is sufficiently obvious. And first of the carbon—

Now I think it better first to state in the form of a proposition an opinion very generally entertained on this subject, and in which, so far as my judgment goes, I heartily concur, and then to enter at some length into the evidence on which that opinion rests—

"The carbon of plants is solely derived from the decomposition of carbonic acid."

The first experiment in relation to this subject dates back to the year 1771, and was made by the celebrated Dr. Priestley. He left a lighted wax taper in a confined portion of air until it expired; into this deteriorated atmosphere he introduced a plant of mint, and suffered it to remain ten days, when he found the air again capable of supporting combustion.* It is to be remarked that this happened three years before the discovery of oxygen by the same person. Very shortly after that great event, Dr. Priestley was led to examine into the nature of the gas which had thirty years before been observed by Charles Bonnet to arise in bubbles from the surface of green leaves immersed in spring water and placed in the sunshine: the gas proved to be nearly pure oxygen. The attention of a number of inquirers, among whom

contains a little light carburetted hydrogen, and indeed Boussingault long ago satisfied himself that something of the kind did, at least occasionally, exist.

* Berzelius, *Lehrbuch der Chemie*, 6, 89.

will be found the names of Ingenhaus, Spallanzani, Sennebier, Théodore De Saussure, and many others, was at once directed to the subject, by the researches of whom it was distinctly shown that this disengagement of oxygen was due to the decomposition of carbonic acid dissolved in the water by the green parts of plants, and further, that it only occurred under the influence of light.

A modification of one of Sennebier's experiments made by the late Auguste de Candolle deserves particular notice. The following is a translation of his own words:—

"I placed on the same pneumatic trough two inverted jars, the one A, as well as the trough, filled with distilled water, in which floated a plant of *Mentha aquatica*; the other B, filled with carbonic acid gas. The water of the trough was covered by a thick layer of oil, to cut off communication for a time with the atmosphere; the whole was exposed to the sun. Every day the gas in the jar B was seen to diminish, and the water to rise, while at the same time a nearly equal quantity of oxygen was collected in the jar A. During the twelve days of the experiment the mint preserved its healthy appearance, while a similar plant placed in a jar of distilled water exhibited signs of decomposition. Thus, in this experiment, carbonic acid gas was seen, as it were, to be distilled and decomposed by the plant, which was nourished by its means. The same experiment was repeated with oxygen in the place of carbonic acid, but no gas was disengaged in the jar containing the plant."*

Dr. Gilly† placed a tuft of green grass in a jar containing a mixture of oxygen, nitrogen, and carbonic acid, and exposed the whole to the sun. After the lapse of four hours, the contents of the jar being examined, the greater part of the carbonic acid was found to be converted into oxygen. The analysis of the air gave:—

	Before Experiment. Cubic inches.	After Experiment. Cubic inches.
Nitrogen	10·507	10·507
Carbonic acid	5·7	0·37
Oxygen	2·793	7·79
	<hr/> 19·0	<hr/> 18·667

Thus, a growing plant in free air is seen to behave in precisely the same way as the water-mint of De Candolle. It is to be noticed that in the experiment related, a disappearance of oxygen to a small extent took place, a fact of some importance.

The following experiments are by Théodore De Saussure:‡—

1. An artificial atmosphere was prepared in a large graduated jar secured over mercury covered with a film of water, consisting

* De Candolle, *Physiologie Végétale*, p. 1—121.

† Lindley's *Introduction*, p. 312.

‡ *Recherches Chimiques sur la Végétation*, p. 40.

of common air mixed with a certain proportion of carbonic acid. Into this vessel seven plants of *Vinca minor*, about eight inches in height, were introduced, and the whole was exposed to the sunshine for six hours during seven consecutive days; on the seventh day the plants were withdrawn in a healthy state and the air examined, when the carbonic acid was found to have disappeared, while in its place oxygen had been disengaged. The following are the details of the experiment:—

	Contents of jar—	
	Before Experiment. Cubic inches.	After Experiment. Cubic inches.
Nitrogen	211·92	218·95
Oxygen	56·33	71·05
Carbonic acid	21·75	0·0
	<hr/> 290·0	<hr/> 290·0

Hence—

	Cubic inches.
Gain of oxygen	14·72
„ nitrogen	7·03
Oxygen assimilated	7·03

2. Experiment repeated in the same manner on a plant of *Lythrum salicaria*. Seven days' exposure sufficed for the removal of all the carbonic acid:—

	Contents of jar—	
	Before Experiment. Cubic inches.	After Experiment. Cubic inches.
Nitrogen	53·33	53·83
Oxygen	14·17	20·67
Carbonic acid	7·5	0·0
	<hr/> 75·0	<hr/> 74·5

Hence—

	Cubic inches.
Gain of oxygen	6·5
„ nitrogen	0·5
Oxygen assimilated	1·0

3. Plant of *Pinus Genevensis*, nine inches high, exposed eighteen days:—

	Contents of jar—	
	Before Experiment. Cubic inches.	After Experiment. Cubic inches.
Nitrogen	205·72	206·75
Oxygen	54·68	67·08
Carbonic acid	19·6	4·17
	<hr/> 280·0	<hr/> 278·0

Hence—

	Cubic inches.
Gain of oxygen	12.4
,, nitrogen	1.03
Oxygen assimilated	7.02

In this last case the conversion of carbonic acid into oxygen was not quite completed even after the lapse of eighteen days; but this is easy to understand, since the change in question is effected by the agency of the green matter of the leaf, which in the pines has but little development in comparison with the extent of surface possessed by many plants.

Water-plants decompose carbonic acid and evolve oxygen by the aid of light. The carbonic acid is in this case derived, in part, from the decomposition of organic matter at the bottom of the brook or pool, which is dissolved by the water, and thus brought within the sphere of activity of the plant. The same observation has quite recently been extended to plants growing in the sea, by M. Aimé, of the French College of Algiers.

These experiments, and a great number of others which might be cited, leave no doubt of the fact that plants possess, to a very great extent indeed, the power of effecting the decomposition in question.

This action is peculiar to the green parts of plants, or those which are capable of becoming green by exposure. It proceeds with the greatest rapidity under the direct rays of the sun: it occurs even in diffuse daylight, but ceases immediately on the withdrawal of the light altogether, when other and completely different phenomena commence. It appears that in the dark, not only does the evolution of oxygen cease, but an actual absorption of that gas occurs; and carbonic acid itself is given off in return, just as in the respiration of an animal, although to a far more limited extent.

The emission of carbonic acid by plants has indeed been ascribed to a real respiratory process, taking place both by day and night, and whose effect is the production of a certain quantity of that gas, while the oxygen, so abundantly liberated under the influence of sun-light, has been referred to a kind of digestion taking place only under those circumstances, in virtue of which carbonic acid is decomposed, the carbon assimilated, and the oxygen set free, so that during the day the effect of the proper respiration is masked by the more extensive process then going on.

This explanation is a very ingenious one, but it is not completely borne out by what we know of these processes in the animal system. However true it may be that the assimilation of

carbon, and consequent liberation of oxygen gas, is the result of something like digestion, it is much more likely, as Liebig suggests, that the evolution of carbonic acid, probably at all times, is due to merely chemical actions constantly going on, and not to any vital process whatever. We know that this effect is constantly produced by moist vegetable matter, especially when a little albuminous substance is present. Even wetted sawdust, placed in a vessel of oxygen, occasions the conversion of that substance into carbonic acid; and it would be very odd if the green matter of the leaf (the chlorophylle, a body exceedingly prone to change) did not possess this property. Again, if we imagine, what is very likely to be true, that the acid principles of the plant are formed by the oxidation of such bodies as starch and sugar, we have another source of carbonic acid, which usually makes its appearance in such reactions—an abundant one in some particular cases, but perhaps commonly of less importance than the first mentioned. The permanent disappearance of a portion of oxygen is also explained in this manner. Its office is to carry off hydrogen from the bodies in question.

Once more, vegetables pump up from the soil and exhale from their leaves an enormous quantity of water. Now this water, for a reason presently to be described, is always largely impregnated with carbonic acid, which must thus be sent into the air with the aqueous vapour, unless light be present to induce its decomposition.

Now comes the important inquiry—does the quantity of oxygen emitted by a plant during the day, under ordinary circumstances, exceed that abstracted from the air by the same plant during the night? In other words, is the ultimate effect of a growing plant upon the air, after a succession of days and nights, the same as that produced by an animal, that is, its vitiation; or the reverse?

Some of De Saussure's best experiments, among which may be placed the examples before quoted, besides those of others, in which the process was suffered to go on for more than one day, lead to a very decided affirmative. In an artificial atmosphere, containing a very far larger proportion of carbonic acid than is ever found in the air (for plants exposed to light can bear this increase, up to a certain point, without injury, although they perish when the quantity becomes excessive), the oxygen has been seen day by day to increase nearly at the same rate as the carbonic acid diminished, so long as the plant retained its healthy state, until the proportion contained in the experimenting jar showed a very notable excess over the normal quantity of the atmosphere.

These experiments, and the conclusions deduced therefrom, have been called in question by some observers, and that recently,

by whose researches it appeared rather doubtful whether, after all, plants do really possess this purifying power with respect to the air. In experiments connected with subjects like the present, the greatest possible care and foresight are required to guard against accidental sources of error, which beset the observer on every side. The discrepant results obtained by so many different individuals abundantly testify to the truth of this observation. For example, during all experiments of this nature, every precaution must be taken to keep the plant in a healthy state. If it dies, or any portion dies, or even becomes diseased, its proper functions diminish in energy, and even cease, and decomposition commences—a process whose constant concomitant is the disappearance of oxygen, and its change into carbonic acid.

We owe to Professor Daubeny a most valuable set of experiments in relation to this matter, which appear to demonstrate the point, so far as it is capable of demonstration by such means.

In these researches bell-jars of large dimensions were employed, dipping into mercury, covered with a little water, contained in a kind of double cylinder of iron, the plant or branch experimented upon being secured within, and cut off from the atmosphere by an ingenious contrivance described in the memoir. The jar being so arranged, and the plant introduced, a certain portion of carbonic acid was supplied, and the air of the apparatus carefully examined, and the relation of the carbonic acid, oxygen, and nitrogen, carefully determined. During the experiment this analysis was repeated from time to time, fresh portions of carbonic acid being added as that substance became decomposed. The result of a long series of experiments on a great variety of plants, and under varied circumstances, are given in tables in the memoir referred to. They are all (with the exception of one or two cases, in which thick-leaved, fleshy plants were concerned) decidedly in favour of the view advocated. The following are the details of two experiments:—

“The jar contained about 600 cubic inches of air. The plant experimented upon was the common lilac. The proportion of carbonic acid in the jar was each morning made equivalent to five or six per cent. The first day no great alteration in the air was detected; but on the second day, by eight in the evening, the oxygen had risen to 26·5 per cent. In the morning it had sunk to 26, but by two p.m. it had again risen to no less than 29·75, and by sunset it had reached 30 per cent. At night it sunk one-half per cent.; but the effect during the day was not estimated, as the sickly appearance which the plant now began to assume induced me to suspend the experiment.

“In a second trial, however, the branch of a healthy lilac growing in the garden was introduced into the same jar, and suffered to remain until its leaves became entirely withered. The first day the increase of oxygen in the jar was no more than 0·25 per cent., but on the second it

rose to 25. At night it sunk to nearly 22 per cent., but the next evening it had again risen to 27. This was the maximum of its increase; for at night it sunk to 26, and in the morning exhibited signs of incipient decay. Accordingly, in the evening, the oxygen only amounted to 26·5, the next evening to 25·5, the following one to 24·75, and the one next succeeding it had fallen to the point at which it stood at the commencement, or 21 per cent. The reason of this decrease was, however, very manifest from the decay and falling off of the leaves; so that this circumstance does not invalidate the conclusion which the preceding experiments concur in establishing, namely, that in fine weather a plant, so long at least as it continues healthy, adds considerably to the oxygen of the air, when carbonic acid is freely supplied.

"In the last instance quoted, the exposed surface of all the leaves inclosed in the jar, about 50 in number, was calculated at not more than 300 square inches; and yet there must have been added to the air of the jar as much as 26 cubic inches of oxygen, in consequence of the action of this surface upon the carbonic acid introduced. But there is reason to believe that, even under the circumstances above stated, the amount of oxygen evolved was much smaller than it would be in the open air; for I have succeeded, by introducing several plants into the same jar of air in pretty quick succession, in raising the amount of oxygen contained from 21 to 39 per cent., and probably had not even then attained the limit to which the increase of this constituent might have been brought."*

These experiments are admirable. There is one point, however, which Dr. Daubeny does not notice, namely, the alteration in the whole volume of the gas by the plant, connected with a very curious observation of De Saussure—the exhalation of nitrogen. It appears that something of this kind occurs in animals, and it is a subject worth examining. To take into account, however, any change of volume of the air in a large jar would involve certain corrections at each time of observing, which would materially increase the labour attending such experiments.

Such is the nature of the experimental evidence in favour of the supposition. We need not, however, confine ourselves to watching the growth of a plant in a glass jar. The observation of the great phenomenas of nature seems indisputably to lead to this conclusion:—

"The mere observation of a wood or a meadow is infinitely better adapted to decide so simple a question than all the trivial experiments under a glass globe: the only difference is, that instead of one plant there are thousands. When we are acquainted with the nature of a single cubic inch of the soil, and know the composition of the air and rain-water, we are in possession of all the conditions necessary to their life. The source of the different elements entering into the composition of plants cannot possibly escape us, if we know in what form they take

* Phil. Trans. for 1836. See, also, Three Lectures on Agriculture. Murray. 1841.

up their nourishment, and compare its composition with that of the vegetable substances which compose their structure." *

Go now, and examine plants which grow entirely in a state of nature, quite uncultivated. Take a pine forest growing in a barren sand like the Landes of Bordeaux, and note the rapid growth of the timber, and the quantity which can consequently be every year cut down and removed, without diminishing the total amount. Examine, also, the soil in which the trees grow from year to year, and note its *constantly increasing richness in "humus"—in vegetable matter*. Far from exhausting the soil in this respect, these trees pour out constantly from their rootlets matter containing carbon, which, by decay in the soil, becomes humus. The dead leaves, and small branches accidentally broken by the wind, accumulate beneath, and add to this store of humus; and in the end, when the trees themselves have perished, a soil has been prepared capable of supporting all the plants that the climate will suffer to live. Whence did these trees obtain their carbon?—The earth did not yield it: it must have been the air.

To ascribe the origin of the carbon of plants, in a state of nature, to the absorption of humus from the soil in which they grow, is about as reasonable as to suppose the possibility of a race of animals subsisting on their own offspring. That substance is a *product of the decay of previously existing plants*, which *must* have got their carbon from some other source. Its quantity, moreover, increases every year; and if this latter fact is not true with respect to some cultivated soils, it is easy to see the reason in the greatly accelerated destruction of this substance by the oxygen of the air, brought about by the constant loosening of the soil. Add to this the very slight degree of solubility possessed either by humus itself or by the so-called "humate of lime," and it is easy to see its total inadequacy to supply even a small part of the carbon fixed in a growing plant.

The result of nearly all the great chemical actions constantly going on at the surface of the earth—combustion, the respiration of animals, the putrefaction of organic matter—is the production of carbonic acid, and that in very large quantities. According to an estimate given, a little town of 7000 inhabitants, where wood is consumed for fuel, and that sparingly from its high price, more than one thousand millions of cubic feet of oxygen are annually withdrawn from the atmosphere by this combustion alone, and a great part of it consequently returned to it in the shape of carbonic acid! Add to this the amount produced by respiration,

* Liebig, Agricultural Chemistry, p. 44.

taking the very lowest estimate, and then calculate how much of this poisonous gas is annually poured into the atmosphere by one single large city.

Processes going on beneath the surface of the earth are often fruitful sources of carbonic acid. A German writer, Bischoff of Bonn, quoted by Liebig, considers that from the ancient volcanic district of the Eifel, near Coblenz, on the Rhine, no less than ninety thousand pounds of carbonic acid are daily sent into the air from this small spot alone. Consider the number of active and extinct volcanoes in various parts of the world—along the range of the Andes, for example—and think how largely these contribute to the contamination of the air. And yet, after these actions, or at least some of the most potent among them, have been going on in all probability for periods of time so vast as to surpass conception, the quantity of carbonic acid in the atmosphere amounts but to $\frac{1}{100000}$ th part of its volume. It is impossible to doubt that some efficient method for its removal has been provided, and that method is the agency of plants. The carbonic acid thrown into the air from so many sources is by them removed: its carbon furnishes them food, while the oxygen (useless in such abundance to vegetable, but absolutely required for the maintenance of animal, life) is sent back again to perform its proper function. Animals and plants are thus mutually subservient to each other's existence.

The source of the hydrogen of plants will present little difficulty. It is derived from the decomposition of water—at least in great part. As a large portion of every plant consists of substances in which the oxygen and hydrogen are in the relation to form water, no excess of oxygen will attend the production of these bodies; but in resinous and oily products generally, oxygen will be liberated, and will add itself to that set free from the carbonic acid.

Nitrogen, in the shape of albuminous matter, appears to be indispensable to the development of living plants in every stage of their existence. The immense provision of that substance in the seeds of most vegetables is a proof of its importance; and the care which nature has thus taken to guard against any deficiency in this respect, to the young plant, is very remarkable. We are ignorant, however, of the precise duty it fulfils, and mere conjecture will advantage us but little.

The origin of this nitrogen, present in all vegetables, is an inquiry of very great importance. There is no difficulty in showing, by a process of reasoning similar to that used in relation to the carbon, that, if not the whole, by far the greater part of the nitrogen contained in wild plants—forest-trees, for example—

has been obtained from the air. The soil cannot possibly have yielded it in sufficient quantity to form the various azotized products always present, in very notable proportion, in such cases: we must once more look to the atmosphere.

Again, to use an illustration of Boussingault,* let us suppose a well-managed farm, so extensive and so well conducted that no importation of manure from beyond its limits is ever practised: it is easy to see how, by duly apportioning the land between the culture of grain and other produce, and the rearing of animals, the dung, &c., of the latter may be made fully sufficient for the purposes of the former. Now, every year a large quantity of nitrogen, principally in the shape of wheat and other dry grain, is sent out of the farm, and exchanged for money and other things which may be required, yet at the expiration of a term of years the land shall be even in a better state than at first. It is impossible to arrive at any other conclusion than that the excess of nitrogen spoken of has been taken up from the air.

What is here treated as a supposition has been very recently demonstrated† to take place in ordinary culture: the nitrogen supplied by the manure laid on the land has been positively shown to be totally insufficient to furnish the different crops with their azotized matter. These researches were conducted by a method which in careful hands cannot fail to lead to results infinitely better and more trustworthy than those got by causing plants to grow under unnatural circumstances. We are indeed deeply indebted to Boussingault for having applied to the solution of questions like the present the exact processes of modern organic chemistry.

A piece of cultivated land was marked out and treated in the same manner as the rest. A strict account was kept of everything relating to it—the quantity of manure put upon it, the weight of the different crops raised, and so forth, during the whole period of five years occupied by a complete rotation. Having these data, by the aid of a sufficient number of exact analyses of the manures and products to get a mean result sufficiently near the truth to be trusted, we can easily understand that a good approximation was arrived at towards a knowledge of the relative proportions in which the earth and the air contributed to the support of the plants.

I subjoin one of the tables given by the author, in which some of his results are presented in a very convenient form, and refer my readers to the paper itself, which deserves a careful study.

* *Ann. Chim. et Phys.*, 67, 14.

† Boussingault, *Ann. Chim. et Phys.*, Feb. 1841.

Year.	Nature of Crop.	Produce per Hectare.	Dry Produce.	Carbon.	Hydro- gen.	Oxygen.	Nitro- gen.	Salts and Eartha.
1st.	Potatoes . . .	12,800	2,085	1357·4	178·9	1379·0	46·3	123·4
2nd.	Wheat . . .	1,343	1,148	529·3	66·6	498·2	46·4	27·5
	Straw of do. . .	3,052	2,258	1093·0	119·7	878·2	9·0	158·1
3rd.	Clover, dried . .	5,100	4,029	1909·7	201·5	1523·0	84·6	310·2
4th.	Wheat . . .	1,659	1,418	653·8	82·2	615·4	32·6	34·0
	Straw of do. . .	2,770	2,790	1360·4	147·8	1063·2	11·2	196·3
	Turnips . . .	9,850	716	307·2	39·3	302·9	12·2	54·4
5th.	Oats . . .	1,344	1,064	539·5	68·0	390·8	23·3	42·6
	Straw of do. . .	1,800	1,283	642·8	69·3	500·4	5·1	65·4
	Sum . . .	40,418	17,791	8383·1	973·3	7179·9	250·7	1010·9
	Manure used . .	49,086	10,161	3657·6	426·8	2621·5	208·2	3271·9
	Difference . . .		+7,630	+4745·5	+346·5	+4351·4	+47·5	-2261·0

The numbers express "kilogrammes"—the kilogramme is equal to 2·2 lbs. avoirdupois, very nearly.

The French land measure, the "hectare," is equal to 107,600 square feet, or 2·47 acres English.

Now comes the question—is this nitrogen, thus taken up, the free nitrogen of the air, or is it derived from the trace of ammonia known to exist in the atmosphere?—The latter view is that adopted by Liebig, and certainly the evidence is in his favour. When azotized organic matter, an animal body for instance, undergoes putrefactive decomposition, it is known that the nitrogen is always disengaged, chiefly in the shape of ammonia: this is constantly the case, the hydrogen and nitrogen presented to each other in their nascent state by the breaking up of the organised body immediately unite. Carbonic acid is also a constant product of putrefaction, and neutralizes the ammonia produced, forming an extremely volatile salt, which rises in vapour into the atmosphere, and there accumulates until the first shower of rain brings it down in a state of solution.

Ammonia is a substance exceedingly interesting in a chemical point of view, from the curious transformation which itself and its compounds are capable of undergoing; and it is easy to trace the peculiar facilities which this Protean nature gives for the production of the complicated azotized principles, such as gluten in the seeds of the grasses, the alkaloids in various medicinal plants, &c.

For plants growing in a state of nature this small but constant supply of nitrogen is amply sufficient; but in those raised by artificial culture, especially when, as in the case of wheat and other grain, the whole plant, and more particularly its azotized

portion, is in a state of abnormal development—a state excellent for the purposes for which the plant is designed by man, but still a forced and unnatural state; the case is changed, and without an artificial supply of this element in an available form, the plants languish and perhaps die.

Hence, *one* of the great uses, but not the sole use, of animal manure, more especially of urine, whose truly wonderful effects have been observed by many. Putrid urine is probably the most valuable manure we possess. The people of the Low Countries and China are well aware of this. It should be collected and husbanded with the greatest care in our towns and cities, which could easily be done if public attention were once directed to this important subject, for the use of the farmer, who cannot value it too highly.

The mode in which this manure acts is quite intelligible, and gives great support to the supposed function of ammonia:—fresh urine contains some 3 per cent. of a white, soluble, crystallizable substance called “urea,” which on contact with water and the mucous matter contained in the urine undergoes, under the influence of this mucus (which acts towards it in all probability in the same manner as yeast does towards sugar), a peculiar change or fermentation, whereby it becomes converted into carbonate of ammonia, and in that state is taken up and assimilated by the plant. It furnishes, in short, the same substance as the atmosphere, the food of plants provided by Nature herself. Moreover, urine contains a large quantity of phosphates, bodies we shall hereafter see indispensable to vegetable life.

If the proposition discussed be true, it follows that the existence of ammonia in the air must have preceded both vegetable and animal life; that substance must have been an original constituent of our globe, and is not all due to putrefaction.

We are destitute of data at present to determine the point whether or not gaseous nitrogen can be fixed in a growing point, and in the absence of such we must not hastily decide that such a thing never happens. It is perfectly true that this substance manifests under ordinary circumstances very little tendency to combine with other bodies, yet we know of two exceptions to this rule, and a diligent search would probably be rewarded by the discovery of others. When nitrogen is mixed with excess of hydrogen, and burned at a jet in oxygen gas, water and nitric acid are produced; and secondly, when pure nitrogen is passed over a mixture of charcoal-powder, and carbonate of potash, cyanide of potassium in quantity makes its appearance.* Thus we see that

* Journal of the Pharmaceutical Society of London, Jan. 1842.

under favourable circumstances this gas can combine directly with oxygen and with carbon, even in our hands; and surely the chemical energies at work in a living plant are, to say the least, equal in power to those which we have under our control in the laboratory. Nevertheless, in the present state of our knowledge, it seems that we must look to ammonia as the general source of the azote found in plants.

In Boussingault's paper already referred to an interesting account will be found of certain experiments on the cultivation of Jerusalem artichokes in Alsace, in which a prodigious quantity of nitrogen is taken up from the air. This culture is carried on *continuously*, the ground being manured every two years. A crop of 23,550 lbs. per acre is obtained from a somewhat shallow soil at Bechelbronn, which is shown to contain no less than 38.3 lbs. more nitrogen than the manure applied, and which must have been derived from the air. It seems difficult at first to imagine that this large quantity could have been got from the very minute trace of ammonia present in the atmosphere; but a little consideration will show that even in this case there is no necessity to suppose an absorption of gaseous nitrogen.

If, taking Liebig's data, we assume one pound of rain-water to contain not more than one-fourth of a grain of ammonia; and the annual fall of rain to amount in round numbers to 4,000,000 lbs. per acre,* this quantity of water will bring down with it in the state of ammonia no less than 117.5 lbs. of nitrogen.

Such then are the conclusions to which we come at the present moment. Setting aside certain mineral matters furnished by the soil, which will be discussed immediately, the only substances really required as food by living plants are carbonic acid, water, and ammonia—*three inorganic bodies*; and that manures owe a great part of their value to the supply of these necessary elements, which they furnish by their decomposition. Vegetables are thus machines for manufacturing out of these few and simple substances the complicated products, albumen, fibrin, casein, starch, sugar, &c., which animals require for their sustenance, while the bodies of the latter when withdrawn from the influence of life, and once more brought under the sole dominion of mere chemical agencies, furnish by their decomposition the food required for another generation of plants.

* Under the mark. The mean of twenty-two years' observations at Paris—a drier climate than that of England—gives for the annual fall of rain 57 centimètres = 22.44 inches. This makes 3240 cubic inches per square foot, weighing 117 lbs. nearly. The English acre contains 43,560 square feet, consequently the weight of the rain per acre will be $43560 \times 117 = 5,096,520$ lbs. yearly.

The Mineral Constituents of Plants.

Every one is aware of the fact that when plants of any description are burned, a quantity of whitish substance, or "ash," remains behind. Different plants, and different portions of the same plant, yield very variable quantities of this residue, but in no case is it absent altogether. Chemical analysis shows this ash to be a mixture of various saline bodies, some soluble in water, others not, siliceous matter, and unburned charcoal. Potash, soda, lime, and magnesia, in union with carbonic, sulphuric, and phosphoric acids; certain portions of chlorides; traces of iron and manganese; silicates, soluble and insoluble, are the principal substances which thus remain after destruction by fire of the organic tissues with which they were associated. The relative proportions of the substances in the ashes of different plants vary exceedingly; sometimes soluble carbonates are largely present, in other cases siliceous matter is the principal ingredient, while occasionally phosphates prevail.

Now, if we take a plant whose ashes furnish a large quantity of carbonate of potash, for example, and examine its juice while living, we shall find this juice, instead of giving the well-known alkaline reaction proper to that salt, is strongly acid; and a more extended investigation shows that this is due to the presence of a vegetable acid, generally tartaric, citric, or malic, so associated with the alkali in question as to constitute an acid salt. When this combination comes to be exposed to heat, the vegetable acid is destroyed, converted into carbonic acid and water, the first of which then unites itself to, and remains in union with, the alkali, such a compound not being further destructible by heat; and so with the other bases when in combination with organic acids, they always remain after combustion as carbonates.

An opinion has widely prevailed that these bodies were accidentally derived from the soil, and could not be considered essential components of the plant, inasmuch as they were found to vary very considerably with the nature of the ground in which the plants grew. Professor Liebig has, in his excellent work so often referred to, devoted a considerable space to the refutation of this idea, and has endeavoured to show from analyses, which at first sight seem to point to the opposite conclusion, that a certain degree of constancy attends the quantity of bases in combination with organic acids present in the same plants grown in different situations, although the proportions of the bases themselves may be very different. He shows that in the ashes of two pine trees, grown under very different circumstances, and which on analysis gave different results, the quantity of oxygen present in the carbonates was very nearly the same, showing that these bases were

associated in the two trees with equal proportional quantities of organic acids. The same thing was observed in two fir-trees, one of which grew in France, the other in Norway. The conclusion arrived at is the following:—every vegetable requires for the fulfilment of its vital functions the presence of a certain quantity of some particular organic acid or acids, of the use of which, however, in the economy of the plant we are yet ignorant; and, further, it is required that these acids be in union with a base. Now, although it appears that such substances as potash and soda, and lime and magnesia, can to a certain extent replace each other in this office, if it should so happen that the supply from the ground is insufficient for the purpose, the plant cannot thrive unless it possess the power, a power which appears very rare, of *secreting an organic alkali for its own use.*

Again, it is known that wheat-straw, in common with the stalks of all the grasses, contains a very large quantity of siliceous matter, while the grain itself contains phosphoric acid, potash, and magnesia. These substances are always present; so far as we know, they are indispensable. A land, the richest on the face of the earth in other respects, must be absolutely barren for corn-crops if it be destitute of these substances, although other plants not requiring them, if such could be found, might flourish in the greatest luxuriance. Why are clay lands in general the most favourable to corn? Because, among other reasons, from the nature of their origin, soluble siliceous salt must be present. Such crops exhaust a soil of this kind by robbing it not so much of its humus as of its salts, and cannot again be advantageously grown upon the same spot until this loss is supplied either by a further disintegration of the soil itself, which happens in a fallow, according to Liebig, or by the addition of suitable manure.

The settlers in the American woods, those who for the first time put the plough into new land, which year after year has for centuries had its surface manured by the decomposing leaves of the forests which before grew upon the spot, and whose deep penetrating roots sought out these saline substances in every direction, raise crop after crop of the heaviest grain without addition of any kind, to the astonishment of the inhabitants of long-settled districts; but even this comes to an end, and the ground refuses to give its increase without an artificial supply of the exhausted elements.

In some of the older provinces of the United States great tracts of once fertile land are described to be lying barren from having been injudiciously forced to grow tobacco, a plant rich in nitrate of potash; and no suitable manure being at hand to recover them, they remain wild and waste.

Such is the state of the case. We have reason to believe that

certain saline inorganic substances are essential to the well-being of plants in general, and of course to those we cultivate for our food, but unfortunately our knowledge of the kind of substance required in each particular case is very, very limited. Such knowledge, invaluable as it would prove, is only to be got by a long series of accurate analyses of the ashes of agricultural produce of various kinds grown upon every variety of land and under every variety of circumstances—a task very unlikely to be undertaken by any single individual. The illustrious Chevreul spent ten years in the study of some half-dozen animal fats, and his investigation remains a perfect model of scientific research; but it is little to be expected that any person in this commercial and manufacturing country, where applications of science to the arts are so well rewarded, and where abstract investigation, at least in chemistry, meets with so little encouragement, will devote his time and energies to an inquiry like the present, unless backed by the countenance of a public association.

I venture to place before the Society the results of a few analyses of the ashes of some of the most important agricultural crops made during the last six months. A small number of isolated experiments like the present go but little way towards the settlement of the question at issue; so far as they extend, however, the agreement between them is complete, and they serve to point out a very remarkable circumstance, namely, that the different parts of the same plant have the power of choice or selection with respect to the mineral food furnished by the soil. The details of the processes employed are given in an appendix.

1. Wheat grown in the Valley of the Thames, in Battersea Fields.

Straw, including heads:—

300 grains gave of ash, by incineration in a open vessel, 20·0 grains.

300 20·8 „

Mean, 6·8 per cent.

20 grains of ash gave, on analysis:—

	In 100 parts.	
Soluble salt—		
Sulphate of potash	2·9	14·5
Silica	0·3	·5
Potash, with silica, chloride, &c. . . .	0·4	2·0
Insol. portion—		
Siliceous scales	14·2	71·0
Earthy phosphates	1·5	7·5
Carb. lime	0·15	0·75
Water	0·2	1·0
Potash, magnesia, and loss	0·35	1·75
	<hr/> 20·0	<hr/> 100·0

Siliceous scales, on analysis, gave :—

Silica	.	.	.	.	13·1
Phosphates	.	.	.	.	0·5
Potash	.	.	.	.	0·5
Charcoal, &c.	.	.	.	.	0·1
					<hr/>
					14·2

Soluble salt converted into chloride, and examined for soda :—

2·8 grains ignited chloride gave 8·8 grains double chloride of platinum and potassium; corresponding to 2·699 grains of pure chloride of potassium.

Grain :—

1000 grains of wheat gave of ash, by incineration, 14·5 grains.
Or, 1·45 per cent.

10 grains gave, on analysis :—

		In 100 parts.
Phosphates of magnesia and lime	. 3·7	. 37
Alkaline phosphate (by difference)	. 5·4	. 54
Charcoal, sandy matter, &c.	. 0·9	. 9
<hr/>		<hr/>
10·0		100

This result must be looked upon as approximative only. There are obstacles in the way of a very exact analysis of these grain ashes, the chief of which are the difficulty of procuring a sufficient quantity to operate on, and the impossibility of separating by the filter the soluble from the insoluble salt, owing to the peculiar character of phosphate of magnesia. The *presence* of a large amount of soluble phosphate was rigidly demonstrated, although the quantity of that substance could only be conveniently obtained by difference; a method liable to a certain degree of error. It is, no doubt, this alkaline phosphate which renders the incineration of this and other kinds of corn so excessively slow and troublesome, by causing fusion to take place unless the heat be regulated with the utmost care.

2. Wheat from Berkshire; land enriched by farmyard manure.

Straw :—

500 grains of entire straw gave of ash . 23·0 grains.
500 23·3 „
The mean gives 4·63 per cent.

20 grains, on analysis, gave :—

	In 100 parts.	
Soluble salt—		
Sulphate of potash . . .	2·65	13·25
Chloride of potassium . . .	0·55	2·75
Insol. portion—		
Siliceous scales . . .	15·5	77·5
Earthy phosphates . . .	0·8	4·0
Carbonates of lime, magnesia, } trace of alkali, and loss . }	0·5	2·5
	20·0	100·0

15·4 grains of siliceous scales gave:—

Silica . . .	13·8
Phosphates and oxide of iron . . .	0·3
Carbonate of lime . . .	0·3
Alkali and trace of magnesia . . .	1·0

15·4

Soluble salt converted into chloride, and examined for soda:—

3 grains of salt gave 9·7 grains of chloride, platinum, and potassium = 2·96 grains of chloride of potassium.*

Grain of preceding straw:—

500 grains of wheat gave of ash, by incineration . . . 6·5 grains.

1000 10·7 „

Mean = 1·18 per cent.

This ash contained in 10 grains—

	In 100 parts.	
Phosphate of potash, with trace of chloride	4·9	49
Phosphates of magnesia and lime . . .	3·6	36
Charcoal and sandy matter	1·3	13
Water	0·2	2
	10·0	100·0

Soluble phosphate converted into chloride, and examined:—

2·7 grains of ignited salt gave 8·4 grains of chloride, platinum, and potassium = 2·57 grains of pure chloride of potassium.

3. Wheat from the same field as the preceding, but manured with nitrate of soda, 1 cwt. to the acre: an experimental crop.

Straw:—

500 grains of entire straw gave of ash . . . 18·8 grains.

500 18·0 „

500 19·9 „

The mean gives 3·78 per cent.

* The absence, to any extent, of soda-salt is thus demonstrated; all the ashes examined gave *traces* of soda, of which no mention is made in the details of each, that base being estimated with the potash. No error can arise from this circumstance.

20 grains of ash gave, on analysis :—

	In 100 parts.	
Soluble portion—		
Sulphate of potash	1·72	8·6
Chloride	0·58	2·9
Silica	0·1	0·5
Insol. portion—		
Siliceous scales	16·0	80
Earthy phosphates, carbonates, } &c. (by difference) . . . }	1·4	7
Water	0·2	1
	<hr/> 20·0	<hr/> 100

16 grains of siliceous scales, by fusion with carbonate of soda, &c., gave :—

Silica	13·7
Phosphates	0·47
Carbonate of lime	0·7
Alkali, and loss	1·13
	<hr/> 16·0

Portion of soluble salt extracted and converted into chloride :—

3 grains ignited gave of double platinum salt 9·05 grains; corresponding to 2·77 grains of pure chloride of potassium.

Hence, a little soda present, which may have been derived from the nitrate.

Grain from the above straw :

500 grains by incineration gave of ash . . .	4·8 grains.
500	5·0 ”
500	4·4 ”
Or, as a mean, ·946 per cent.	

10 grains gave, on analysis :—

	In 100 parts.	
Phosphate of potash	5·3	53
Phosphates of magnesia and lime	3·1	31
Sandy matter and charcoal	1·3	13
Water	0·3	3
	<hr/> 10·0	<hr/> 100

Soluble phosphate converted into chloride, and examined for soda :—

2·8 grains of ignited chloride gave of platinum salt 8·9 grains; corresponding to 2·72 grains of pure chloride of potassium.

4. Barley grown in Battersea Fields.

Straw :—

300 grains of entire straws gave of ash .	20·6 grains.
300	19·7 „
300	21·3 „
300	22·0 „

The mean giving 6·97 per cent.

20 grains gave, on analysis :—

	In 100 parts.	
Soluble portion—		
Sulphate of potash	3·32	16·6
Chloride and little silica	0·08	0·4
Insol. portion—		
Siliceous scales	14·1	70·5
Phosphates of lime and magnesia	1·7	8·5
Carbonate of lime	0·4	2·0
Alkali, magnesia, and loss	0·3	1·5
Water	0·1	0·5
	<hr/> 20·0	<hr/> 100·0

14·1 grains of siliceous scales gave, on analysis :—

Silica	12·3
Phosphates	0·5
Carbonates of lime and magnesia, alkali, and loss	1·3
	<hr/> 14·1

Grain of preceding straw :—

1000 grains gave of ash, by incineration . 24 grains.
Or, 2·4 per cent.

10 grains gave, on analysis :—

	In 100 parts.	
Phosphate of potash	4·3	43
Phosphates of lime and magnesia	2·9	29
Siliceous matter, &c.	2·8	28
	<hr/> 10·0	<hr/> 100

Soluble phosphate converted into chloride, and examined for soda :—

3 grains of ignited salt gave of double chloride 9·3 grains = 2·84 grains of pure chloride of potassium.

5. Rye grown in Battersea Fields.

Straw :—

400 grains of straw gave of ash .	18·7 grains.
400	21·7 „
400	21·2 „

Or, 4·106 per cent.

20 grains of ash contained :—

			In 100 parts.
Soluble portion—			
Sulphate of potash . . .	3.47	.	17.35
Chloride, silica, &c. . .	0.13	.	0.65
Insol. portion—			
Siliceous scales . . .	13.5	.	67.5
Phosphates . . .	1.7	.	8.5
Carbonate of lime . . .	1.0	.	5.0
Alkali and loss . . .	0.2	.	1.0
	<hr/>		<hr/>
	20.0		100.0

Grain of the foregoing ;—

1000 grains' weight of rye gave of ash . 15.5 grains.
Or, 1.55 per cent.

10 grains, on analysis, afforded :—

			In 100 parts.
Phosphate of potash . . .	5.4	.	54
Phosphates of magnesia and lime . . .	3.8	.	38
Siliceous matter and charcoal . . .	0.6	.	6
Water . . .	0.2	.	2
	<hr/>		<hr/>
	10.0		100

6. Common spreading oats, grown in Battersea Fields, in highly-manured soil. The oats were cut before fully ripe: the straw was in a most extraordinary state of development; but the grain itself was dark-coloured, poor, and thin.

Straw :—

500 grains of whole straws gave of ash . 38.0 grains.
500 35.2 „
Or, 7.32 per cent.

The incineration proved very difficult from the fusibility of the ash; a circumstance never observed in the other straws.

20 grains gave, by analysis :—

			In 100 parts.
Soluble portion—			
Sulphate of potash . . .	3.11	.	15.55
Silica . . .	1.35	.	6.75
Potash in union with silica, phos- phate, and little chloride . }	5.94	.	29.7
Insol. portion—			
Siliceous scales . . .	4.65	.	23.25
Earthy phosphates . . .	1.8	.	9.0
Carbonate of lime . . .	1.25	.	6.25
Water . . .	.4	.	2.0
Alkali, &c., and loss . . .	1.5	.	7.5
	<hr/>		<hr/>
	20.0		100.0

Grain from preceding straw :—

500 grains yielded of ash	. 12 grains.
500 . . . . .	. 13 „
Or, 2·5 per cent.	

10 grains gives, on analysis :—

		In 100 parts.
Phosphate of potash, with trace of chloride	3·9	. 39
Phosphates of lime and magnesia	2·3	. 23
Siliceous matter	3·8	. 38
	<hr/> 10·0	<hr/> 100

The ash of this grain thus does not differ sensibly from those of the preceding, except in the proportion of silica in an insoluble state, derived from the inseparable husk. The composition of the straw-ash differs widely from that of all the others, inasmuch as it contains a large proportion of silicate of potash, and also of soluble phosphate; which are both absent, the first nearly, the second completely, in all the rest. Setting aside this apparent exception (which perhaps we may be able in part, at least, to account for), the most important and invariable mineral constituents of the cereals appear, from the experiments, to be *silica and sulphate of potash in the straw, and the phosphates of potash, magnesia, and lime in the seed.*

So far as it is fair to judge from so few cases, although the absolute quantity of ash produced from corn-plants grown under different circumstances may vary very much, yet the composition of the ash itself, both of the straw and of the grain, undergoes very little change.

How shall we account for the introduction of so large a quantity of silica into the plant? The foregoing experiments prove that this is not silicate of potash, but nearly pure silica, and that substance is well known not to be sensibly soluble in water. Possibly the anomalous case of the overgrown oat-straw cut down before complete ripeness, may afford a key to this difficulty. We may conjecture that it is introduced in the state of soluble silicate of potash, which salt is afterwards decomposed in the plant itself by a vegetable acid there produced, the new potash salt being excreted by the roots, or otherwise disposed of. It would be easy to obtain evidence on this point by careful analyses of the ashes of corn-plants from the same field in their green and in their mature state.

It is possible, also, that the absorption by these and other plants of phosphates from the soil, bone-earth for example, may be connected with an acid excretion from their roots, by the aid of which it is rendered soluble; this is, however, merely a conjecture.

It is exceedingly curious to observe that, while the body of a plant may abound in a soluble saline matter, sulphate of potash, its seed may be absolutely destitute of it; and that, while the latter contains abundance of soluble phosphate, the plant itself is quite free from that substance!

7. Lucern from a garden in Battersea Fields—a highly-manured soil: roots rejected.

300 grains of dried plant gave of ash . . . 28·1 grains.

This contained, by analysis—

		In 100 parts.
Carbonate of potash	11·1	39·5
Sulphate of potash	8·65	13·0
Silica	0·49	1·7
Earthy phosphates	5·7	20·3
Carbonate of lime	6·6	23·5
Carbonate of magnesia	0·2	0·7
Loss	0·36	1·3
	28·1	100·0

It is impossible to speak with certainty concerning the arrangement of these substances in the living plant. Perhaps it may be something like the following:—

Potash, combined with vegetable acid and little silica	9·53
Lime, with vegetable acid	3·41
Sulphate of lime	2·87
Phosphate of lime	5·7
Magnesia, with vegetable acid	0·1

The same plant grown in a field close at hand gave an ash almost identical in composition.

8. White clover—Hatcham, near Deptford: light sandy soil.

500 grains of dried plants, without roots, gave of ash 33·5 grains.

20 grains of ash gave, on analysis:—

	In 100 parts.
Carbonate of potash	39·45
Sulphate of potash	12·1
Chloride of potassium	4·7
Silica	1·0
Earthy phosphates, oxide of iron, &c.	30·5
Carbonate of lime	5·0
Sandy matter	4·0
Water	1·5
Loss	1·75
	20·0
	100·0

An ash evidently of the same description as that given by the lucern; a plant of the same natural order.

9. Potatoes from a garden in Battersea Fields; tops.

100 grains of dried tops gave of ash . 23·5 grains.

20 grains contained—

		In 100 parts.
Carbonate of potash	8·21	41·05
Sulphate of potash	1·14	5·7
Chloride of potassium	0·05	0·25
Silica	0·3	1·5
Carbonate of lime	5·9	29·5
Earthy phosphates	2·0	10·0
Sandy matter	2·0	10·0
Water	0·3	1·5
Loss	0·1	0·5
	<hr/> 20·0	<hr/> 100·0

Tubers—cut into thin slices and dried.

500 grains of dried slices gave of ash . 19·5 grains.

800 " Mean = " 4·4 per cent. 39·3 "

20 grains of ash contained—

		In 100 parts.
Carbonate of potash, with a little chloride	10·72	53·6
Phosphate of potash	3·58	17·9
Sulphate of potash	2·7	13·5
Silica	0·1	0·5
Earthy phosphates, with traces of carbonate of lime, magnesia, and oxide of iron	2·1	10·5
Water	0·8	4·0
	<hr/> 20·0	<hr/> 100·0

10. Turnips grown in same garden; tops.

250 grains of dried tops gave of ash . 47 grains.

Or 18·8 per cent.

20 grains gave, on analysis—

		In 100 parts.
Sulphate of potash	5·61	28·05
Carbonate of potash, with a little chloride	3·29	16·45
Carbonate of lime	7·55	37·75
Earthy phosphates, &c.	2·2	11·0
Carbonate of magnesia	0·32	1·6
Sandy matter and loss	0·93	4·65
Water	0·1	0·5
	<hr/> 20·0	<hr/> 100·0

Bulbous portion, cut into thin slices and dried:—

200 grains of dry slices, gave of ash . 20·4 grains.

Or 10·2 per cent.

mixture as the ash of a plant usually presents, and which perhaps, after all, would be unnecessary. A good approximation is sufficient.

It may be proper to mention that the green parts of the garden turnips examined contained a very notable quantity of some nitrate.

Now, it appears to me that, by proceeding in this manner, we may eventually lay the foundation of a rational system of agriculture. If, for example, we were in possession of a set of analyses of sufficient completeness and extent, both of the proximate organic and mineral constituents of all such substances, the proportion of water and other things; this information, combined with a knowledge of the gross weight of such crops, raised on a given space of ground, would enable us so to manage matters that the nature of the food and the extent of its supply should be duly apportioned to each class of plants; and that, instead of annually loading our lands with manures, frequently at a great expense, whose mode of operation we very little understand, and in which it may happen that those very substances wanted are deficient, while others, already redundant, are supplied in injurious excess, we shall be able to proceed in a more systematic manner, and give the kind and quantity of food required, and no more. The thousands of tons of refuse matter rejected every year by those who conduct our immense chemical works of different kinds, may, when these things come to be better understood, be applied to the production of such artificial manures; and the farmer may hereafter be enabled most materially to increase the produce he raises from the soil, partly by the actual augmentation of yearly harvest, but chiefly by the avoidance of the *then* unnecessary fallows and rotation crops.

The Action of Manures.

In the foregoing pages an attempt has been made to convey some notion of the chief conditions required to be fulfilled in order that a plant may live and thrive. We have seen that the food required for the sustenance of vegetables is strictly inorganic, and confined to a very few bodies—carbonic acid, water, and ammonia: may we add, in some cases, nitric acid? These, together with saline matter derived from the soil, are the only substances we know of required for the sustenance of plants, or indeed capable of ministering to their existence; and once more it is well worthy of remark that these are the very substances produced by the functions of animals during their life, and by the decay of their bodies after death.

The science of agriculture will thus resolve itself into a know-

ledge of the methods by which these necessary supplies of food may be most economically and effectually rendered to the plants we wish to cultivate, and of the external circumstances which assist or interfere with the absorption and assimilation of such principles.

Two things in connexion with this subject have been known from the remotest ages : namely, that the same plants grown over and over again in the same soil rapidly degenerate, and at length fail entirely ; and in the second place, that this evil can be, to a very considerable extent, diminished—this exhaustion of the soil, as it has been called, be in part repaired by spreading over the land the excrements of animals. It has also long been known that exhaustion of the soil, to the extent described, may be avoided, and the impoverishing effects of cultivation diminished, by occasionally leaving the land uncropped for a season, exposed to the action of the rain and air, after which it is found to have regained a portion at least of its former fertility.

More recently it has been discovered that this unproductive “ fallowing ” may be entirely avoided, except so far as it is required to cleanse the land from weeds, by cultivating a particular succession of plants, so that two crops of the same kind may be always separated by a certain interval of time. This is what is known by the term, “ system of rotation of crops,” and is in general use throughout Europe, although the particular order of this rotation, as well as the period of time involved by it, are scarcely in any two places the same.

This fact, so familiar to all engaged in practical agriculture, received some years ago, at the hands of the celebrated De Candolle, an extremely beautiful explanation, which obtained what was long considered a kind of proof from a set of experiments made by M. Macaire.* The theory in question supposes that all plants throw out from their roots certain peculiar matters analogous to the excrements of animals, which their system cannot assimilate, and which, if retained in the plant, would occasion its destruction by a kind of poisoning as surely as the suppression of the urinary secretion causes the death of an animal. These vegetable excrements, thus accumulated in the soil during the life of one particular set of plants, cannot of course supply nourishment to those individuals, but at the same time they do not produce upon them any very notable amount of injury, because the roots of these plants are constantly lengthening, and thus removing the spongioles, by whose aid absorption is supposed to occur, from the spots occupied by the deposited poison ; but let another race of the same plants be cultivated on the ground immediately after

* *Ann. Chim. et Phys.*, 52, 225.

the removal of the first, and these poisonous principles are brought into active operation to the detriment of the new-comers.

The theory further supposes, that although the excrements of one plant are incapable of affording nourishment to another of the same kind, and would even inflict upon it positive mischief, yet to a plant of a totally different family these very substances may serve as nutritious food; that the fecal matters accumulated in the soil during the growth of a crop of wheat, although injurious to another crop of grain, may afford food to a fresh set of plants, such as clover, which in their turn excrete substances hurtful to themselves, but exceedingly nutritious to corn.

Macaire, in his investigation before referred to, observed that, when plants were made to grow in pure water for several days, soluble matter was certainly emitted from the roots, which could be detected both by its colour, taste, and smell, and also by chemical re-agents, and that this soluble matter differed very much with the kind of plant. He further observed, that water charged with the excrements of a leguminous plant, although decidedly injurious to another of the same kind, suffered a plant of wheat, whose roots were immersed in it, to live perfectly well, while at the same time the yellow colour of the water diminished in intensity.

It is a very great objection to such experiments that they are made under conditions never fulfilled in nature. It is impossible that a plant thus situated can maintain a healthy state even for a few days. From what we now know of the nature of vegetable nutrition, plants so treated must be living upon their own resources to a great extent, like hyacinth bulbs grown in glasses of water. Moreover, attempts to obtain these specific excretions, by causing the same plants to grow in moist sand, completely failed. Some important observations, since made by Braconnot,* throw great doubt on the fact of specific substances being ejected from the roots of plants, of such a nature as to act in the manner described.

There are two especial reasons for the rejection of this theory at the present moment. The small chance such substances would have of escaping destruction in the soil, by the oxygen of the air, even for a very brief period; and the fact, now rendered pretty certain, that bodies of this kind are quite incapable of nourishing plants by direct absorption: they can only furnish food by their decomposition into carbonic acid, and water, and ammonia.

A better explanation is to be found in the ancient idea of exhaustion of soil, aided by what little knowledge we already possess of the kind of nourishment given by the ground to each class

* *Ann. Chim. et Phys.*, 72, 27.

of plants, more especially the saline or mineral substances indispensable to such plants, and the nitrogen, sparingly furnished by the atmosphere, but in nearly all cases of artificial culture largely required. It is to supply the deficiencies thus occasioned that we have recourse to manure.

Now, it must be the object of every good farmer to follow such a rotation system as shall economise to the utmost extent his farmyard manure, the supply of which must of necessity be limited, by cultivating in the intervals of his corn crops those plants which subsist to the greatest extent on atmospheric food, and which are at the same time useful as fodder or otherwise, so that while very little saline matter is taken from the ground, large quantities of carbon and nitrogen may be withdrawn from the air, and transferred to the soil through the agency of the plant, in the shape of roots, residue, &c., afterwards ploughed in, and furnishing by their decomposition humus and ammonia. It is thus possible to imagine that by such means a sufficient supply of azotized matter even for grain might be got from the air alone without the use of animal manure at all; but then it is impossible to select plants which do not, to a certain extent, rob the soil of salts, and thus at length destroy its fertility. Every one which has been examined contains more or less phosphate for example, and unless some artificial provision is made for a supply of such substances, the system cannot go on.

It happens that in ordinary farmyard dung all the principles thus gradually lost by the soil are to be found in abundance: the decomposed straw furnishes silica in a minute state of division, still having with it a little potash and various saline substances; the solid animal excrements contain abundance of earthy phosphates, as direct analysis has shown; while the urine gives up by its putrefaction at once carbonate of ammonia and more phosphate, besides smaller proportions of other principles: the only thing at all defective is potash, and that frequently exists plentifully in the soil, and is gradually liberated by disintegration.

In fact, it can hardly be otherwise: the quantity of saline and azotized matter contained in the body of an animal at the end of its life is but small compared with that furnished by the food consumed, and since, except perhaps a little nitrogen, nothing is lost by respiration but carbon and hydrogen, the excess of azote and salts must be sought for in the excretions, and there accordingly they are to be found, and found also in that state most fitted for again passing into the vegetable form.

The subjects have been so ably and so fully discussed by Liebig in his admirable treatise, now in the hands of all interested in agricultural pursuits, that a further detail becomes unnecessary: I could only give his matter in worse words. I subjoin the

analysis of the ashes of a carefully-selected portion of farmyard manure, the result of which fully confirms the beautiful views of the author referred to:—

Farmyard horse manure, two years old—East Greenwich: sample selected from the middle of the heap, and dried completely in the sun:—during the latter part of the incineration, ammonia was disengaged, probably from the action of the moisture of the air on a cyanide—

500 grs. produced of ash . . . 124 grains.

20 grains gave, on analysis—

		In 100 parts.
Sulphate of potash	1.36	6.8
Sol. chlorides, with trace of alkaline carbonate }	2.94	14.7
Earthy phosphates, ox. iron, &c. . . .	6.8	34.0
Carbonate of lime	2.4	12.0
Siliceous scales	6.5	32.5
	20.0	100.0

Every hundred pounds of dry dung placed on the land is thus seen to convey to it no less than 8.4 pounds of phosphates of lime and magnesia.

As I have no intention of entering into the much-disputed question of the propriety of using this manure in its recent state, or after a certain amount of decomposition, it will only be necessary to remark that those who actually cause its complete desiccation, as related by the Rev. Mr. Rham, in his interesting account of the agriculture of the Netherlands,* by no means destroy the whole, or even perhaps the greater part of its value, as the practice fully proves, although a large portion of what ammonia may exist in it is dissipated and lost.

A suggestion is to be found in Liebig's paper which deserves great attention; he proposes to prevent the loss of ammonia during the fermentation of the urine in the tank in which it is collected by mixing with it some cheap mineral acid which would deprive it of volatility. In an experiment made in the course of the summer, I found that when fresh urine was mixed with oil of vitriol the decomposition of the urea went on as if no acid were present; a peculiar odour was emitted during the change, not quite agreeable it is true, but infinitely less annoying than the mixture of ammoniacal gas and sulphuret of ammonium given off by putrefying urine. Two gallons of human urine produced enough ammonia to neutralise very nearly seven ounces by weight of oil of vitriol.

* Journal of the Royal Agricultural Society, vol. ii. p. 43.

So far then, the experiment succeeds, but before applying it extensively, it would be necessary to know more concerning the real effect which different ammoniacal salts produce on vegetation: an inquiry of great importance, and one to which the attention of those desirous of following out agricultural investigation should be particularly directed. Should the result of the inquiry be favourable, a few pounds of oil of vitriol, a very cheap substance, or hydro-chloric acid, thrown away by hundreds of tons by those who manufacture carbonate of soda from salt, or perhaps even common gypsum, strewed upon the dunghill or put into the reservoir, may be the means of getting rid of an offensive nuisance, and at the same time of preventing the waste of a most valuable substance. Night-soil might be so treated, instead of the plan now sometimes adopted of mixing it with lime, and thus at once throwing away all the ammonia.

It must not be forgotten that although the general opinion now seems to be that manures for the most part act by affording food itself to plants, an idea has been, and still is, entertained by some, that certain ones at least of these substances act in the same manner as stimulants to animals. The best argument against this hypothesis is the fact that in plants nothing like a nervous system can be seen; besides, when the office which each kind of manure fills in actually giving nourishment to a plant can be distinctly traced, it seems unnecessary to resort to any other mode of explanation.

I proceed, in accordance with the prescribed conditions of the essay, to offer a few remarks on certain other manures, some of which promise to be of value.

Under the general term "manures" are comprehended two classes of substances, namely, those which, like the animal ejections, furnish food to plants, and those which merely improve the texture of the soil, and which are much better described by the word suggested by De Candolle, "ameliorations." These latter do not require consideration; it is perfectly evident that a stiff, heavy soil must be improved by an admixture of sand; a loose sandy soil by clay, &c.; but there are others, such as lime and burned clay, which are more complex in their mode of action. Hydrate of lime, for example, appears to induce a more rapid decay of vegetable matter, which is sometimes, as in peaty soils, in excess; when in a state of carbonate it frequently improves the physical condition of the land and it also enters into the plant as direct food, generally in combination with an organic acid: it may happen, although it is probably a rare occurrence, that there may not exist in the soil a sufficient quantity of lime to serve the last-named purpose. Burned clay confers porosity on a heavy land, and probably, as Liebig remarks, performs another import-

ant office, that of abstracting ammonia from the air: oxide of iron, an abundant constituent of clay, having a great attraction for that substance. In the same manner, gypsum or sulphate of lime performs the double function of serving directly as saline food, and fixing the carbonate of ammonia of the rain-water, which would otherwise in great part evaporate from the surface with the water itself.

Manures, properly so called, may be divided into azotized and saline, or those which give nitrogen, and those which restore to the soil the mineral nourishment withdrawn from it by plants: there is a third and most important class, to which urine belongs, the members of which perform both services.

Among the saline manures we have gypsum, already mentioned; wood-ashes, valuable for potash, salts, and phosphates; soot, valuable for its sulphate of ammonia, and perhaps for its carbon, which, from an experiment of Davy, seems to undergo slow oxidation by exposure to air and water;* &c.

The only purely azotized manure is the ammoniacal liquid of the gas-works; a very variable mixture of sal-ammoniac and sulphate of ammonia, with generally a large proportion of sulphuret of ammonium and small quantities of other substances. This liquid has been tried by many persons as a manure for corn, but with very variable success, as may be expected from its indefinite nature. In a little experiment which came under my own observation, wheat so treated grew up in the rankest and most luxuriant manner, presenting a deep green colour strongly contrasting with another portion of the same corn to which none of the manure had been applied. The best mode of using this substance will certainly be to reduce it to an impure ammoniacal salt, sulphate, or chloride, so as to get rid of the sulphuret, sulphite, &c., which can hardly fail to be prejudicial to vegetable life, and then to apply such salt scattered over the ground in a sparing manner: always on the supposition that the compounds mentioned have been shown to be capable of assimilation by the

* Analysis of coal and coke ashes:—

	Staffordshire Coal.	Newcastle Coal.	Staffordshire Coke.
Sandy matter and unburnt charcoal . . .	64.0	87.6	76.8
Oxides of iron and manganese, alumina, and some phosphoric acid }	9.8	3.6	7.0
Carbonate of lime	12.8	1.0	4.6
Sulphate of lime	2.44	0.54	3.8
Alkaline sulphate, with trace of chloride and sulphuret }	0.4	1.26	0.8
Water	8.8	4.6	4.6
Trace of magnesia, and loss	1.76	1.4	2.4
	100.0	100.0	100.0

plant ; otherwise we must make it into carbonate, the use of which will be extremely wasteful.

The principal mixed manures are :—

Bones—an exceedingly valuable manure, although of necessity costly : bones contain nearly half their weight of animal matter exceedingly rich in nitrogen, which slowly decays, giving rise to ammonia ; the rest being phosphate of lime with a little carbonate. Hence, when observing the wonderful effects of bone-dust on certain crops, we can be at no loss to account for what happens. The use of this substance has been mostly confined to turnips ; so far as I have heard, its effects on other plants, such as wheat, which requires large quantities both of azote and phosphoric acid, are by no means so remarkable. Is this fact connected with some acid excretion from the roots of the turnip, by the aid of which the phosphate is dissolved ; and which does not take place to so great an extent in other plants ? and could we not, as Liebig himself proposes, treat the bones first with dilute mineral acid, and so increase the effect ?

Fish have been used in many localities by the sea-side with a good result ; they contain much albuminous matter and oil, the use of which is not however very clear. Rape and linseed cake and “ graves,” or the refuse of the tallow-melter, bits of membrane impregnated with fat, belong to the same list. Hair, woollen rags, feathers, dried blood, animal flesh, and such like substances, are all extremely valuable, but difficult to get in any quantity ; they differ very much in the rapidity with which they undergo decomposition, the effect of the two last-named being much more sudden and transient than that of the former.

When a soil is deficient in humus, the use of which seems to be to furnish by its ceaseless decomposition a source of carbonic acid to the roots of the plant, more particularly valuable in the early part of its life, peat earth, especially when brought into a state of decay by mixing it with a portion of stable-manure, will prove an useful addition. It has often struck me that the dead leaves which encumber towards winter our parks and woodlands, collected in the latter part of the autumn, and either ploughed into the ground at once, or first made into a compost heap, would prove of great service ; they would furnish nitrogen, and humus, and silicate of potash, and many other salts, all highly useful.

There now remain but two other manures which deserve particular notice, namely, the “ guano ” of the South Seas and the nitrates of potash and soda. The first-named substance is the partly decomposed excrement of birds, accumulated in beds of almost incredible thickness on some of the uninhabited coasts and islands of the Southern Pacific, consisting, according to an old analysis of MM. Fourcroy and Vauquelin, of uric acid, partly

saturated with ammonia and partly with potash, phosphates of these bases and of lime, a little sulphate and chloride, and some siliceous sand.

The guano is described by Sir H. Davy in his admirable lectures on agricultural chemistry, but seems to have been forgotten until the publication of Liebig's volume, since which a small quantity has been imported. It is a substance deserving the attention of agriculturists, as it is one of those manures best able to bear the expense of transport, containing much valuable matter in a small space.

An excellent paper on guano, by Professor Johnston, is to be found in the last published Number of the Journal of the Society, to which the reader is referred. This paper contains an account of some experiments made with the substance as a manure, which were decidedly successful, a set of new analyses, and some remarks on its use, which deserve attention. Unfortunately, however, for the English farmer, it seems not improbable, from the statements referred to, that the supply itself is likely after a time to fail, as the increasing commerce along the coast frequented by the sea-birds has already in part driven the latter from their accustomed haunts, and thus interfered with the production of the substance. Guano is a substance exceedingly variable in composition, and, consequently, in value—a point which must be kept in mind. The following analysis, on the authority of Völkel, made on a specimen of a quantity brought from Valparaiso * will serve as an illustration of its general nature.

100 parts contained—

Urate of ammonia	. . . .	9.0
Oxalate of ammonia	. . . .	10.6
Oxalate of lime	. . . .	7.0
Phosphate of ammonia	. . . .	6.0
Phosphate of magnesia and ammonia	. . . .	2.6
Sulphate of potash	. . . .	5.5
Sulphate of soda	. . . .	3.8
Sal-ammoniac	. . . .	4.2
Phosphate of lime	. . . .	14.3
Clay and sand	. . . .	4.7
Various organic matters, a little soluble salt of iron, and water	. . . . }	32.3
		100.0

The occurrence of so much oxalic acid is a curious subject of speculation; it must be a result of the chemical changes which the guano is constantly undergoing, and which form the principal

* *Annalen der Chemie und Pharmacie*, pp. 39, 289.

cause of the enormous difference in composition found even in different specimens taken from the same mass.

The mode in which this substance acts, and the nature of the food it furnishes to corn plants, must be obvious from a glance at its composition—it closely resembles in this respect that type of a good manure, putrefied urine, in the immense quantity of azotized matter and phosphates which it contains; and we can be at no loss to understand how it is that by the use of such a substance the barren plains of Peru may for the time become converted into fruitful fields.*

Nitrates of Potash and Soda.—There are probably no substances capable of being used as manures upon which more experiments have within a recent period been made than upon these salts, and especially upon the last, as its price is not generally so high as that of the former, in consequence of the large supply, and partly, perhaps, from its uselessness in the manufacture of gunpowder. It is necessary to state, however, that hitherto no satisfactory general result has been arrived at; some experiments on various kinds of crops have been attended with the most marked success, while in others either no perceptible difference was produced, or still worse, the result was a failure. A number of such experiments are related in the second volume of the Journal of the Society, but it is impossible to deduce from them any general conclusion.

Among the most important communications is that of Mr. Hyett, from a statement it contains of a very remarkable circumstance, which, if confirmed by future experiments, will place the advantage of this manure on a higher footing than that which

* Two specimens of South Sea guano, subsequently examined by the author, gave the following results:—

No. 1. Pale brown, soft, and highly offensive—

Oxalate of ammonia, with trace of carbonate, undecomposed	}	66·2
uric acid, brown organic matter, and water		
Earthy phosphates, with very little sandy matter		29·2
Alkaline phosphate and chloride, with little sulphate		4·6
		<hr/>
		100·0

No. 2. Darker in colour, less offensive, and evidently more advanced in decomposition: it contained no uric acid—

Oxalate of ammonia with little carbonate, organic matter, and water	}	44·6
Earthy phosphates, with little gritty matter		
Alkaline sulphates, chlorides, and phosphates (both potash and soda, the latter most abundant)		41·2
		14·2
		<hr/>
		100·0

—(*Proceedings of Chemical Society of London*, vol. i. p. 36.)

arises from the mere increase in the quantity of grain when the salt is used as a top-dressing for wheat.

It is well known that the proportion of gluten in flour varies very much in different samples of the same grain, according to the circumstances under which it has been grown, and especially the kind of manure used. The experiments of Herbstœd and Boussingault sufficiently prove this; so that by the use of a richly-azotized manure, such as urine or putrid blood, the proportion of gluten, the most valuable part of the flour, may be prodigiously increased. Now the same thing is, according to Mr. Hyett, effected by the use of nitrate of soda. In the case by him described the gluten was raised from 19 to 23·25 per cent.—a most important difference.

I am indebted to the kindness of friends for the means of repeating this experiment. Among the analyses of the ashes of wheat before given will be found those of an experimental crop raised in Berkshire,* in the same field, and as nearly as possible under similar circumstances, except that one-half was treated with nitrate of soda, and the other not. The experiment was decidedly a successful one, the produce being considerably increased.

It will be seen from the analysis referred to that no important alteration of the inorganic constituents of the crop occurred under the influence of the nitrate; a little more soda than common seemed to have been introduced into the straw, but nothing more. The value of the manure is thus due to the nitric acid.

In the Appendix will be found a description of a mode of determining the proportion of gluten in meal of different kinds, which promises to give results infinitely more to be relied on than those got by the old process of mechanical separation. This consists in ascertaining the per-centage of nitrogen present by the aid of the ultimate analysis, and then referring the nitrogen to gluten, on the supposition that that substance contains very nearly 15·5 per cent. of azote—a supposition which the analyses of Dr. Bence Jones and others in Liebig's laboratory have shown to be not far from the mark. In this manner the following results were obtained:—

1. Wheat grown in Battersea Fields last year, well dried in the air: a portion was carefully ground in a mortar, and the bran separated by sifting through fine muslin. It contained in 500 grains:—

* By T. H. Smith, Esq., Kintbury, Berks, to whom I take this opportunity of returning thanks; and also to Charles Alderman, Esq., of Kintbury, for his many acts of polite attention.

Flour	.	.	.	.	.	356 grains.
Bran	.	.	.	.	.	144 „
						<hr/>
						500 „

A portion of the finest flour dried at 212° for some hours, and examined for nitrogen :—

	Per Cent.
10·43 grains gave a quantity of nitrogen corresponding to	1·64
10·34 „ „ „	1·67.

The mean is 1·655, which, reckoned to dry gluten containing 15·5 per cent. of nitrogen, gives, for the per-centage of gluten in the flour, 10·7.

2. Wheat from Berkshire, not nitred ; 500 grains contained :—

Flour	.	.	.	.	.	325 grains.
Bran	.	.	.	.	.	175 „
						<hr/>
						500 „

Flour dried at 212° :—

10·55 grains gave a quantity of nitrogen corresponding to 1·39 per cent., or 8·97 per cent. of dry gluten.

10·26 grains gave a quantity of nitrogen corresponding to 1·41 per cent., or 9·1 per cent. of gluten.

3. Same wheat manured with nitrate of soda. It contained—

Flour	.	.	.	.	.	323 grains.
Bran	.	.	.	.	.	177 „
						<hr/>
						500 „

Flour dried at 212° :—

10·39 grains of flour gave nitrogen corresponding to 1·48 per cent., or 9·55 per cent. of gluten.

10·3 grains of flour gave nitrogen corresponding to 1·56 per cent., or 10·06 per cent. of gluten.

So that the extreme pair of these experiments only makes the increase of gluten 1 per cent., a quantity probably not much above the limit of error of the experiment. This point cannot yet be considered settled.

In terminating these remarks on the subject of manures, I beg once more to call attention to the salts of ammonia. Should these really be found to produce the beneficial effects anticipated, we shall possess at home, within the limits of our own island, resources for the improvement of agriculture, compared with which guano, and nitrate of soda, and all such things, are quite insignificant—resources which only require to be judiciously used to produce the most extraordinary results.

Coal contains nitrogen. When distilled at a red heat for the purpose of getting illuminating gas, the greater part of this nitrogen unites with hydrogen, and gives rise to ammonia, which is afterwards separated more or less completely, and manufactured, although frequently in a very wasteful and imperfect manner, into ammoniacal salt. Admitting that coal contains 1 per cent. of nitrogen, which can thus be employed (a supposition probably not far from the truth), it is easy to see what a prodigious quantity of ammonia might be furnished by our coal-gas works, properly conducted.

According to Dr. Ure, in the year 1838 the quantity of coal so distilled in London alone amounted to 180,000 tons, containing at 1 per cent. 4,032,000 lbs. of nitrogen, equivalent to 4,896,000 lbs. of ammonia!—the produce of a single city in one year.

Again, it is a supposition, certainly within the mark, that every person, one with another, gives rise to 1 lb. of urine every day, containing, according to the estimate of Berzelius, about 210 grains of urea. Taking the present population of London at two millions, this gives 60,000 lbs. of urea *daily*, or 21,900,000 lbs. yearly of this valuable substance THROWN AWAY—a quantity capable of producing by its decomposition 12,410,000 lbs. of ammonia. Could one-fourth of this ammonia be converted into flour, it would produce the astonishing quantity of 159,687,500 lbs.

APPENDIX.

1. *On the Analysis of Soils.*

THE exact analysis of a soil, taking into account the precise nature, quantity, and state of every ingredient, many of which occur in extremely minute quantities, is a chemical problem, perhaps the most difficult that could be devised, and which the science in its present state is hardly competent to solve.

To give such a mode of approximative analysis as shall be exceedingly useful, without pretending to fulfil these conditions, is the object of the following remarks:—

The plan described is based on that recommended by Davy, namely, the separation of the soil into sand, finely divided matter, and salts, and differs principally from those in use by a more careful examination of the fine part, which is subjected to a regular process of mineral analysis. The sand and soluble matters are separately examined as usual.

The sample of soil taken from the field with the usual precautions is exposed to the air until sensibly dry; in this state a portion is weighed out, dried at about 300° Fahr. and the loss of water ascertained. It is next carefully elutriated with distilled water, by which the soluble part is taken up and the sand and clayey portion separated; the sand is then strongly dried, weighed, and its chemical nature examined.

The liquid, holding the finely divided matter in suspension, is then put on a weighed filter, and the proportion of that substance, after proper drying, ascertained; but here a practical difficulty occurs: the mixture often refuses to filter, the finely divided substance closing the pores of the paper, so as greatly to protract that process, while what liquid does come through passes muddy. This inconvenience is obviated by boiling the whole in a glass flask for an hour, when filtration takes place more readily. Even after this I have found, when operating on clayey soils, that the filtered liquid cannot be obtained clear, in which case it should be evaporated down in a porcelain vessel to a small bulk and again put upon a little weighed filter. In this manner the difficulty is got over, but a slight error is involved by the action of the boiling water upon the humus, whereby a small portion is taken up and the solution rendered yellowish, but this quantity is very small, as the examples to be adduced will show. When the suspended finely divided matter of clay soils is suffered to stand, even for many days, although the greater part settles down, the liquid remains turbid, and if examined for salts in this state, would certainly cause a larger error than that mentioned above.

The clear yellowish liquid so obtained, which usually amounts to about a pint, holds in solution all the soluble saline constituents of the soil, including the gypsum, unless, indeed, that substance is present in very large proportion. It is evaporated to dryness without ebullition in a small platinum capsule, and the residue weighed, ignited to redness until the charcoal is burned away, and again weighed.

There now remains to be examined the finely divided substance.

The first thing to be done is to determine the proportion of organic matter; to do this *exactly* would be a very difficult task. After much thought I am inclined to the opinion that the old plan, that of calcination, is likely to give, when properly conducted, a result quite as good as that which might be obtained by a more complicated process. A convenient portion of the substance, well dried at 300° and in fine powder, is heated to redness in an open platinum crucible until all blackness disappears, when the loss of weight after cooling gives the quantity of organic matter; a little too high from the water disengaged from the clay at this high temperature. So far as appears to me this error can hardly rise to 2 per cent.

The calcined substance is next mixed with four times its weight of dry carbonate of soda, and fused in the same platinum crucible at a good red heat for 15 to 20 minutes; the melted mass is softened by water and then treated, with the precautions proper to these processes, with excess of hydrochloric and a little nitric acid, the whole evaporated to dryness, acidulated water added, and the insoluble silica collected on a filter, washed, ignited, and weighed.

To the solution and wash-water, concentrated by evaporation, ammonia is added, which precipitates alumina, oxide of iron, and the little earthy phosphates which may exist in the substance; the quantity of the latter is however so small, that in this analysis it may be safely neglected. The precipitate, well washed, is then heated with dilute caustic potash, which dissolves the alumina and leaves the oxide of iron,

which is lastly re-dissolved in acid, precipitated by ammonia, collected, washed, ignited, and weighed.

The alkaline aluminous solution is mixed with a solution of hydrochlorate of ammonia, the alumina washed, dried, and after ignition weighed.

The ammoniacal solution from which the two last bodies have been separated is reduced to a small bulk, the lime estimated by oxalate of ammonia, and the magnesia by phosphate of soda and ammonia in the usual manner. A little oxide of manganese sometimes occurs, which requires, when its quantity is at all notable, an additional process for its extraction.

Operating thus and using great care, I was surprised to observe that sometimes a deficiency was to be found in the result of the analysis very far greater than could be explained by any error of experiment. This happened with three strong clay soils from Worcestershire belonging to the new red sandstone formation, and as more than one repetition of the experiment gave the same result, there could be no other conclusion drawn but that something had been overlooked; this could only be alkali in an insoluble condition.

To settle the point, a proper quantity of finely divided matter was mixed with five times its weight of pure precipitated carbonate of lime, and ignited to whiteness in a platinum crucible for half an hour: the strongly aggregated mass was then treated with dilute hydrochloric acid, evaporated to dryness, and the silica separated, washed, dried, ignited, and found to agree in quantity with that obtained by the other process. The solution was mixed with excess of carbonate of ammonia, filtered, the soluble portion evaporated to dryness and ignited to expel the ammoniacal salt. The residue in the crucible, freed from a little lime and magnesia which yet remained, consisted of a white saline substance having all the characters of chloride of potassium, and whose quantity, when referred to potash, was just sufficient to make up the above-named deficiency.

This experiment, which was repeated several times with the same success, suffices to demonstrate the existence, in the soils examined, of potash in an insoluble condition to an extraordinary extent, doubtless as silicate, and which in the cases referred to amounts to nearly 2 per cent. of the whole. It is much to be desired that this should be further investigated.

It would be exceedingly difficult to determine with precision the quantity of phosphoric acid in a soil*—a question of great importance. The following process answers exceedingly well for the detection of this substance, and also for getting some idea of its scarcity or abundance:—

A suitable quantity of the soil, about 500 grains, is boiled for some hours in a few ounces of water containing 100 grains of pure carbonate of potash, by which a deep brown solution is obtained and ammonia disengaged. This solution, after being filtered, is evaporated to dryness and ignited in a platinum crucible to char and destroy the organic

* This opinion has not been altered by a careful perusal of Sprengel's elaborate treatise on the subject of the analysis of soils, Oct. 1843.

matter, water is then poured upon the mass, and the whole placed upon a filter; the solution is next to be neutralised with nitric acid and acetate of lead poured in, which throws down sulphate and phosphate of lead. The mixed precipitate is collected on a little filter, washed, suspended in water, and decomposed by a stream of sulphuretted hydrogen gas. After warming and filtration the solution is neutralised by ammonia and tested for phosphate by nitrate of silver, and sulphate of magnesia with excess of ammonia.

The latter test is an exceedingly valuable one, as it often happens that the quantity of phosphate is very small, and the chloride has not been wholly got rid of by the above process; in such a case nitrate of silver will act equivocally. By adding to the suspected solution, however, in succession, a drop of solution of sulphate of magnesia, a little sal-ammoniac, and then an excess of ammonia, a precipitate of the triple phosphate will make its appearance if phosphoric acid be present at all.

All the soils which I have examined, treated in this way, yielded phosphoric acid: from garden-mould the quantity was really very considerable.

It is almost unnecessary to add that if gravel or large vegetable fibres, and such accidental substances, exist in the soil examined, they must be separated by a sieve and an account kept of them.

The following will serve as examples of the application of the process:—

No. 1.—Old grass-land from Hanbury, Worcestershire:—

500 grains by drying at 300° Fahr. lost . . . 12·4 grains.

By elutriation, &c. it gave—

Siliceous sand containing much oxide of iron 256·0 ”

Finely divided matter 229·6 ”

Soluble substances—

Organic 0·7 grains.

Inorganic 0·5 ”

Water 1·2 ”
12·4 ”

499·2

Finely-divided matter analysed by the method described:—

25 grains gave—

		In 100 parts.
Silica	17·1	68·4
Alumina	2·55	10·2
Oxide of iron	2·95	11·8
Carbonate of lime	0·2	0·8
Carbonate of magnesia	0·1	0·4
Organic matter, “humus”	0·9	3·6
Potash, by lime process	1·02	4·08
Loss	0·18	0·72
	25·0	100·0

Distinct evidence both of phosphoric acid and of ammoniacal salt.

No. 2.—Tilled field, A ; same locality.

500 grains taken—

Highly ferruginous quartz-sand	.	.	.	.	188.25	grains.
Finely-divided matter	.	.	.	.	288.8	"
Salt, &c.	{	organic	.	1.8	grains.	
		inorganic*	.	0.75	"	
					2.55	"
Hygroscopic water	.	.	.	.	20.05	"
					499.65	"

Analysis of finely-divided matter :—

25 grains yielded—

		In 100 parts.
Silica	16.4	65.6
Alumina	3.2	12.8
Oxide of iron	2.5	10.0
Carbonate of lime	0.3	1.2
Carbonate of magnesia	0.05	0.2
Organic matter	1.5	6.0
Potash, by separate process	0.88	3.52
Loss	0.17	0.68
	25.0	100.0

Phosphoric acid present, as usual.

No. 3.—Tilled land, B ; same place as last.

500 grains of soil gave—

Sand	.	.	.	.	238.15	grains.
Fine matter	.	.	.	.	243.25	"
Salt, &c.	{	organic	.	1.7	grains.	
		inorganic†	.	0.8	"	
					2.5	"
Water	.	.	.	.	15.45	"
					499.35	"

Analysis of finely-divided matter :—

25 grains gave—

		In 100 parts.
Silica	15.0	60.0
Alumina	3.3	13.2
Oxide of iron	2.8	11.2
Carbonate of lime	1.2	4.8
Organic matter	1.7	6.8
Potash, by other process	1.07	4.28
Trace of magnesia	..	..
	25.07	100.28

* Consisted of carbonate of lime from the decomposition of a little organic salt, sulphate of lime, and soluble chloride.

† Carbonate and sulphate of lime and common salt.

No. 4.—A rich black mould from Battersea Fields, in the Valley of the Thames.

500 grains gave—

Quartz sand	398·2 grains.
Finely-divided matter	81·0 „
Soluble principles } organic	1·6 grains.
} inorganic*	0·8 „
Water	2·4 „
	17·7 „
	<hr/> 499·3

Analysis of finely-divided matter :—

25 grains gave—

		In 100 parts.
Silica	13·7	54·8
Alumina	2·3	9·2
Oxide of iron	2·65	10·6
Carbonate of lime	1·1	4·4
Carbonate of magnesia	0·1	0·4
Organic matter	5·0	20·0
Trace of insol. potash, and loss	0·15	0·6
	<hr/> 25·0	<hr/> 100·0

Abundance of phosphoric acid to be found; also ammoniacal salt.

It is a very remarkable circumstance (already alluded to in the beginning of this paper), that strong, heavy clay soils, like the three first, should not contain more than 7 per cent. of alumina; that this small quantity should confer on the soil so much plasticity and adhesiveness. It is probable, however, that the oxide of iron contributes largely to this effect in the cases cited.

2. Analysis of Ashes of Plants.

The processes adopted in the analyses, of which the results are given in the body of the essay, will be most easily rendered intelligible by an example.

Analysis of the ashes of wheat, Battersea Fields :—

Straw.—A portion of ash boiled in water and filtered. Solution neutral: gave no precipitate with carbonate of potash; no indication of phosphate by magnesia test; abundant white precipitate with chloride of barium, insoluble in nitric acid; also some chloride with nitrate of silver.

Portion of solution concentrated by evaporation, and mixed with solution of tartaric acid, gave, on agitation, abundant crystalline precipitate.

Matter insoluble in water treated with dilute hydrochloric acid, no perceptible effervescence, and only a small portion dissolved; filtered solution evaporated to dryness, and acidulated water added. Insoluble matter almost inappreciable. To the solution ammonia added, which gave a precipitate of phosphates; filter: solution examined for lime

* Chiefly sulphate of lime and common salt.

and magnesia, contained a little of each. Another portion evaporated to dryness, and ignited left a minute residue of chloride of potassium.

Precipitated earthy phosphates dried, powdered, and fused, with excess of carbonate of soda; fused mass treated with water, and placed on filter. Solution examined for phosphoric acid, and insoluble matter for lime, magnesia, and oxide of iron.

From the above it was inferred that the soluble portion of the ash consisted of sulphate of potash, with a little chloride; and the insoluble matter of siliceous scales (to be further examined), phosphates of lime and magnesia, small portions of carbonates of those earths, and a trace of potash.

Quantitative Analysis.

20 grains of ash lost by gentle ignition 0·2 grains.

Water added, boiled, and filtered; solution acidulated with nitric acid, evaporated to dryness, acidulated water poured on the residue, and filtered: silica washed, dried, and ignited 0·3 „

Acid solution mixed with chloride of barium, boiled and filtered: sulphate of baryta, ignited 3·8 „

= 2·9 grains of sulphate of potash.

Matter insoluble in water, gently ignited, weighed . . . 16·2 „

Treated with dilute hydrochloric acid, and filtered; matter insoluble in acid, ignited 14·2 „

Acid solution mixed with ammonia, filtered; phosphates, ignited 1·5 „

To solution oxalate of ammonia added, filtered; carbonate of lime 0·15 „

Hence,—

Soluble salt . 3·6	{	Sulphate of potash	2·9
		Chloride, by difference	0·4
		Silica	0·3
Insoluble part 16·2	{	Siliceous scales	14·2
		Phosphates	1·5
		Carbonate of lime	0·15
Water	{	Potash, magnesia, &c.	0·35
			0·2

20·0

Grain.—Portion of ash treated with water, solution distinctly alkaline; refused to filter. Nitric acid added, no effervescence, but greater portion dissolved; filtered, black sandy matter remained.

Solution mixed with ammonia and warmed, by which a very abundant white granular precipitate was thrown down; this washed, dried, ignited, and examined proved to be a mixture of phosphate of magnesia with a little phosphate of lime:—Ammoniacal solution contained neither lime, magnesia, sulphuric nor hydrochloric acids; a portion evaporated to dryness and ignited yielded a residue consisting of phosphate of potash.

Quantitative Analysis.

10 grains of ash lost nothing by ignition.

Treated with hydrochloric acid and filtered, left of unburnt charcoal and sandy matter	0·9 grains.
Solution mixed with ammonia and filtered; phosphates weighed after ignition	3·7 „

Hence the ash contained—

Phosphates of magnesia and lime	3·7
Sandy matter, &c.	0·9
Alkaline phosphate by difference	5·4
	<hr/>
	10·0

The value of an analysis made in such a manner depends altogether on the care with which the qualitative examination has been made, and the absence of all other substances completely established. The difficulty of obtaining a sufficient quantity of material to work upon is a great bar to any more elaborate investigations; the simplicity of the ash, however, renders these needless.

When the soluble part of an ash contains carbonate, sulphate, and phosphate, an exact analysis becomes very difficult. I have in such cases contented myself with determining the two latter by precipitation, by baryta, and taking the carbonate by difference. Perhaps it would be as well to check this result by determining directly the carbonic acid, which could easily be done, and the quantity of alkali by its saturating power, if great accuracy were required.

I have assumed the composition of phosphate, of baryta, precipitated by excess of ammonia, to be represented by the formula—



The determination of the quantity of potash in a mixture of a salt of that base with one of soda presents no difficulty. The salt is converted into a chloride by means which need not be here described; a portion is then placed in a platinum crucible, gently ignited, and its weight ascertained; it is next dissolved in a little water, and mixed with four times its weight of the double chloride of platinum and sodium in crystals; when the decomposition is complete, alcohol is added, and the insoluble yellow salt placed upon a weighed filter, washed with dilute alcohol, dried at 212° and weighed. From the weight of this, the double chloride of platinum and potassium, it is easy to calculate the quantity of chloride of potassium which it contains.

On the Determination of Gluten in Grain.

The method which has hitherto been usually had recourse to for this purpose consists in making the meal to be examined into a paste with cold water, and kneading it in the hand in a little stream of water until the latter is no longer rendered milky by the separated starch; in the beginning of the operation the paste is inclosed in a piece of rag, but towards the end it is usual to retain it in the palm of the hand without any envelope. When it is thought that the washing has been conducted

to a sufficient extent, the gluten is dried and weighed. This is the method used by Davy in his analyses.

Boussingault,* some years ago, having occasion to make a number of such experiments, in which accuracy was required, speedily found that this method could never be trusted; he rejected it, and substituted the ultimate analysis, assuming from data of his own, that real gluten in a pure and dry state contains 15 per cent. of nitrogen.

This nitrogen analysis has hitherto, from its difficulty of execution and somewhat imperfect results, been the great stumbling-block of organic chemistry: still, it was a happy thought to put it in the place of the still more imperfect plan of mechanical separation.

Within the last few months a new mode of determining the nitrogen in organic substances has been devised and put into execution at Giessen, which promises to be of the greatest advantage to science by reason of the facility with which it is conducted, and of the sharp and beautiful results it affords; results which, so far as I can judge from my own experiments and those of the authors of the process, MM. Will and Varentrapp, equal at least in accuracy those of the carbon and hydrogen determination. The following is the principle:—When any organic substance containing nitrogen, *except a nitrate*, is heated to redness with excess of hydrate of potash or soda, the water of the hydrate suffers decomposition, its oxygen attacks the carbon of the substance, and its hydrogen the azote, which is thus wholly and entirely converted into ammonia. By collecting this ammonia, therefore, and ascertaining its weight, we could easily calculate the quantity of nitrogen in a given weight of the substance.

The practice is as follows:—A mixture is made of about two parts quicklime and one part hydrate of soda, and reduced to fine powder; a convenient quantity of the organic body is brought to a proper state of dryness, weighed and intimately blended with some sixty times its weight of the lime and soda mixture. The whole is then introduced into a tube of hard Bohemian glass, eight or nine inches long, drawn out to a point as in the carbon and hydrogen estimation. To this tube is connected, by means of a cork, a little glass apparatus on the principle of a Woulfe's bottle, containing dilute hydrochloric acid.

Arrangements being thus made, the tube is gradually ignited from end to end by the aid of a charcoal fire, the ammonia disengaged is absorbed by the acid, and the hydrogen, carbonic acid, and other incondensable gases escape. When the operation is ended, the point of the tube being broken, air is drawn through the apparatus to sweep out any ammonia that may linger in the combustion tube.

The acid liquid now contains, provided the experiment has been properly conducted, the whole of the ammonia generated by the nitrogen of the organic substance analysed. It is transferred to a porcelain capsule, mixed with a quantity of pure chloride of platinum, and evaporated to dryness in a water-bath. Upon the residue is poured a mixture of alcohol and ether, which dissolves the excess of chloride of platinum, but leaves untouched the yellow double chloride of platinum and ammo-

* Ann. Chim. et Phys., 65, 301.

nium, which is placed upon a little weighed filter, well washed with the alcoholic mixture, dried at 212° , and weighed. Every hundred parts of this salt contain $6\cdot346$ parts of nitrogen.

One great advantage of this process is that the error is divided by 16, in consequence of the nitrogen being reckoned from the heavy platinum salt. It appears peculiarly applicable to the analysis of bodies containing but little nitrogen, a problem which has hitherto presented much practical difficulty.

To judge how far the new nitrogen process could be applied to the analysis of such a body as meal to determine the proportion of gluten (and a more severe trial of the process itself could hardly have been devised), it was thought right to repeat the analysis of two of the samples of wheat-flour described in the essay, which were made by the new plan, using for the purpose the old "absolute method," and adopting every precaution that could be thought of to diminish the error of excess to which this method is subject. A large quantity of flour was burned, and the exhaustion of the tube made as complete as possible by the aid of a very powerful air-pump, instead of the little hand-syringe generally used. The following are the results:—

1. Flour from Battersea wheat.

Quantity taken . . . 19·19 grains.

This produced $1\cdot25$ cubic inches of nitrogen at 60° , which, corrected for moisture and pressure, was reduced to $1\cdot24$ cubic inches, weighing $0\cdot3739$ grains, or $1\cdot95$ per cent.

The other process, the error of which is in defect, gave $1\cdot64$ and $1\cdot67$ per cent.

2. Flour from nitred wheat, Berkshire.

Quantity taken . . . 19·89 grains.

This produced $1\cdot2$ cubic inches of nitrogen at 60° , which, corrected for moisture and pressure, fell to $1\cdot187$ cubic inches, weighing $0\cdot358$ grains, or $1\cdot8$ per cent.

The new method gave . . . $1\cdot48$ and $1\cdot56$.

6, *Coventry Street, Haymarket,*
October 2, 1843.

MISCELLANEOUS COMMUNICATIONS AND NOTICES.

XV.—*On the Steeping of Seeds.* By J. CAMPBELL.

To the Secretary.

SIR,—At the late agricultural show held here, under the patronage of the Highland and Agricultural Society of Scotland, on the 8th, 9th, and 10th ult., I exhibited specimens of oats, barley, wheat, and ryegrass, raised from seed chemically prepared, which were favourably noticed in the Society's Report.

On the 17th of July I sent a communication to Sir Charles Gordon, Secretary of the Highland Society of Scotland, from which the following is an extract:—"It is now a considerable time since I began to imagine that if the ultimate principles of which the proximate constituents of most of the gramineous seeds are composed could by any means be made so to enter the substance of the seed, and at the same time not to injure its vitality, as thoroughly to imbue its texture with an excess of these principles, the end (*viz.* of superseding manures) would be accomplished; and it is by doing this to a certain extent that I am convinced I have succeeded."

The specimens which I exhibited were raised from seeds steeped in sulphate, nitrate, and muriate of ammonia, and nitrates of soda and potass, and combinations of these; and in all cases the results were highly satisfactory. Seeds of wheat, for example, prepared from sulphate of ammonia, and sown on the 5th of July, had by the 10th of August, the last day of the show, tillered into *nine, ten, and eleven* stems of great and nearly equal vigour; while seeds of the same sample, *unprepared*, and sown at the same time in the same soil, had not tillered into more than *two, three, and four* stems.

The specimens of oats, prepared from sulphate of ammonia, were magnificent both as to height and strength, being six feet high, and having stems like small canes, and consisted of an average of ten stems from each seed, and 160 grains on each stem. The oats from muriate of ammonia were vigorous, and equally prolific, but not so tall; and those from the nitrates of soda and potass were nearly equally prolific, but still less tall.

The specimens of barley consisted of an average of eleven and a half stems from each seed, and thirty-six grains on each stem, and were prepared from nitrate of ammonia. Big or bear, from the same preparation, had an average of eleven and a half stems from each seed, and seventy-two grains on each stem.

Rye-grass, prepared and unprepared, and sown both at the same time and in the same soil, presented a striking contrast, the former being much more vigorous, and of a deeper green than the latter.

I prepared the various mixtures from the carbonates of the above specified salts, which were exactly neutralized, and then added from 8 to 12 measures of water. The time of steeping varied from fifty to ninety-four hours, at a temperature of about 60° Fahrenheit. I found, however, that barley does not succeed if steeped beyond sixty hours. Rye-grass, and other gramineous seeds, not cereal, do with from sixteen to twenty hours.

My experiments were all made in ground which had received no manure for eleven years, and in which there was little organic matter of any kind.

For the purpose of instituting exact comparisons between prepared and unprepared seeds, I sowed seeds prepared in seven different ways, alongside of others in the *natural* state, on the 14th and 16th ult., in pure sand and gravel, and in virgin earth dug 6 feet from the surface, and spread over poor soil, on a farm which I have in Kinross-shire, at an elevation of 400 feet above the level of the sea; but having to leave the place on the 31st ult., I could not form a correct estimate of the comparative growth. I intend, however, to visit the place on the 12th of October, when I shall be able to judge correctly both of the difference of the prepared and unprepared seeds, and also to satisfy myself of the real value of the preparations on inferior soils.

I am, Sir,

Your most obedient servant,

JAS. CAMPBELL,
of Crookmill.

Seminaries, Dundee, 20th Sept., 1843.

Mr. Campbell has subsequently sent the following communication as to the results of the unfinished experiments noticed in his former letter:—

The salts were neutralized by adding the carbonates till effervescence completely ceased, and this was done that there might be no excess of acid.

With respect to the experiments which I purposed to examine on the 12th of October, I have the satisfaction of mentioning that they were completely successful, showing a decided contrast in favour of the prepared seeds. In the tilly soil, dug up from 6 or 8 feet under the surface, the prepared seeds showed plants with *seven* and *eight* stems, while the unprepared had not more than *three*.

XVI.—*Proposed Method of Taming a Savage Bull.*

By ERASMUS GALTON.

SIR,—As I heard last week of a farm-servant being nearly killed by a bull, and as I sometimes hear of valuable bulls being killed on account of their being too savage to be safe, I have ventured to send you a plan to prevent bulls from injuring persons or animals of any kind. But, in case you consider this plan of too trivial a nature to be of general use, I request you will put my letter and its contents into the fire; as I have no doubt you are much troubled with useless communications.

The plan I send I have used, with perfect success, with a very savage bull I bought. Any blacksmith can make it; the cost about five shillings: and it does not cause any annoyance to the animal when he does not try to use his horns.

b is a cap screwed on the end of the horn; *ac* is an iron rod hanging on a pivot in the cap—a chain from it leads to a ring in the bull's nose. The end of the rod *ac*, at *a*, fig. 1, ought to be in a line from the root of the horn to the end of it; so that, in attempting to touch anything with his horn, the point *a* comes in contact with it, when of course the rod *ac* takes the position of one of the lines in fig. 2, *de* or *gh*, and punishes the bull by forcing up his nose.

I turned a three-year-old savage bull with a cow that was bulling, and also turned a yearling bull with them; in a few minutes the young bull found that he was master, and punished the old one very severely: and I was shortly after able to take off the irons, and as long as I had him he never offered to hurt a person, although when I bought him he had tossed several people, and was sold to me as incurable.

I have, &c.,

ERASMUS GALTON.

*Loxton Manor House, near Cross,
Somersetshire, June 13, 1843.*

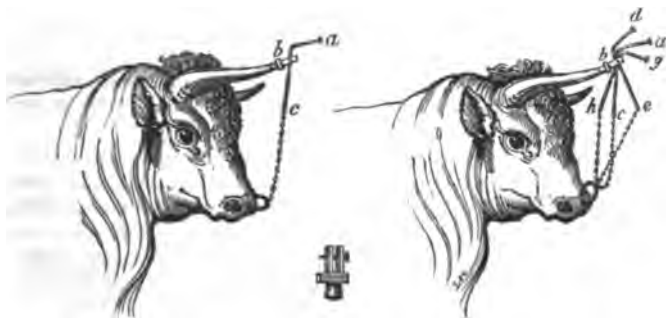


Fig. 1.

Fig. 3.

Fig. 2.

The Cap that screws
on the horn.

XVII.—*Practical Opinions on the Effect of Crosskill's Clod-Crusher.*

THINKING that it might be useful to obtain from those who had used Mr. Crosskill's clod-crusher an account of its action upon their respective farms, I requested him to make the inquiry of them; and the following Tables contain extracts from their answers, classed under five different heads.

PH. PUSEY.

Query 1.—How far valuable for crushing clods, and for breaking up the strongest fallows in the driest seasons?

YORKSHIRE

	Query 1—Crushing Clods.	Query 2—Strong Lands.
H. S. THOMPSON, Kirby Hall.	For breaking clods after turnips, eaten on the land late in the spring, and on land in course of preparation for fallow crop, it is very useful, in at once reducing clods, so hard that the harrows made little impression on them. I consider your patent clod-crusher an exceedingly valuable implement.	
T. ALMACK, Bp. Burton, by Beverley.	Invaluable.	
THOMAS JACKSON, Mouth, Beverley.	A most valuable implement. After breaking up my tenacious turnip-land, I have had considerably finer and better crops than before.	Very satisfactory.
THOMAS DOWARBY, Holmpton, Holderness.	I could not work my strong land to get it into a good state without your clod-crusher.	
T. WHEATLEY, Neswick, Driffield.	In the preparation of strong land, when particularly hard, your clod-crusher has completely pulverized it, when uses of all other implements have been vain.	It is never used to more advantage than upon wheat, rolled in the spring; only let it be dry enough for its use.
Rt. Hon. A. DUNCOMBE, Kilnwick Percy, by Pocklington.	Upon some of my land, in a rough and bad state, we could not do without your crusher.	
R. DENNISON, Kilnwick Percy, by Pocklington.	Nothing can excel it. I have two of your patent clod-crushers in constant use.	Very good.
H. P. CHOLMELEY, Brandsby, by York.	A most valuable implement for breaking up my fallow-land. We could get no turnips without the use of it.	It reduces all the large clods, and brings the land into a very good state.
Rev. S. CRYKE, Wigginton Rectory, York.	I consider it of the greatest utility.	I have always rolled new-sown whenever the weather will advantage upon both soils.

Query 2.—How far valuable, upon strong lands, for rolling corn as soon as sown, and lands sown late in the year, which are cloddy in the spring?

Query 3.—How far valuable, upon light lands, for rolling corn as soon as sown, and in the spring, after frost?

Query 4.—How far valuable in stopping the ravages of the wireworm and grub?

Query 5.—How far valuable upon grass-lands, upon mossy lands, and worm in meadow-lands?

REPORTS.

Query 3—Light Lands.	Query 4—Wireworm and Grub.	Query 5—Grass Lands, &c.
Of great value in giving firmness to light land immediately after sowing, both for wheat and spring crops, as it gives a peculiar closeness to the soil, which enables it to retain moisture at the same time that it leaves the surface rough, and therefore not liable to scarp. It has been one of the principal means whereby I have been enabled to grow very heavy wheat-crops upon land which was considered not very good wheat-land.		
Of great utility in both cases.		
On one part of my farm, which is of a light, peaty nature, it is far superior to the presser in preventing the wheat-plant from rooting up by frost in the winter.	Most valuable in stopping the ravages of the slug or grub, on my strong land, by rolling the seed immediately after ploughing, in the autumn.	
The oftener rolled the better, on light land, more particularly wheat and oats.		
More valuable even in this than any other use.	A great preventive when corn is coming up.	
I have found it valuable for rolling oats; it does not injure the plants at all.		
corn, with a view to compression, low; and believe it of material ad-		I have frequently, with much advantage, passed the roller over grass-lands, upon which compost has been spread, with a view to pulverize lumps before bush-harrowing.

	Query 1—Crushing Clods.	Query 2—Strong Lands.
W. C. HARLAND, (Agent, Mr. FERNIE), Button Hall, by York.	A most useful implement; by far the best, for this purpose, I have ever tried.	I consider it valuable for rolling land as soon as sown; provided it is dry.
Sir S. CROMPTON, Bart. (Agent, Mr. FAIRF.), Wood-End, by Thirsk.	It effectually breaks down large clods, and enables me to obtain turnips on land on which, without it, there would be no chance of growing them.	It answers well for rolling wheat, after seeds; and also for rolling rough land before sowing barley, &c.
JOHN HUTTON, Sowber Hill, by North Allerton.	I find it most valuable for preparing strong land for turnips; and have no doubt I shall be able to do entirely without summer fallow on my strong lands.	I like it much for winter-sown wheat, rolling it in the spring it makes an excellent seam for clover-seed, particularly on strong land.
W. RUTSON, Newby Wisk, North Allerton.	Most valuable. For crushing clods of any size, three horses work it readily, and enable me to prepare land much sooner than by any other means.	
JOHN FOSTER, Newton, Bedale.	It is invaluable for pulverizing the clods, letting out the seeds and weeds, when no other roller could be able to perform it in a dry season.	It is invaluable for consolidating the land as soon as sown leaving an uneven surface, as it harrowed; and in spring it fastens the root to the soil.
H. NICHOLSON, Rand Grange, Bedale.	A most excellent implement. I never saw anything to equal its effects.	It is invaluable for rolling corn previous to sowing with clover and small seeds.
R. BRIDGE, Ripley, Ripon.	I cannot make use of terms too highly laudatory of its value and use under this head.	Very useful in rolling wheat in spring, and more particularly after clover-seed is sown.
J. WHITAKER, Burley, Otley, Leeds.	Of the greatest benefit when the land is dry.	
H. SMITH, Drax Abbey, Selby.	The most valuable implement I have seen for strong land.	It is very useful in spring, and when the turnip-land is hard.
J. BROWN, Wrangbrook, by Pontefract.	The best implement I have seen.	Very valuable.
C. CHARNOCK, Ferry Bridge, by Huddersfield.	Exceedingly useful: in fact, I have often said it has enabled me to set the seasons at defiance.	I have found it extremely useful on wheat, as soon as sown in the autumn, and again in the spring.
Rev. T. CATOR, Skelbrooke Park, by Doncaster.	For limestone and stiff soil, one of the most useful implements in husbandry.	
R. TAYLOR, Goolthorpe, by Tickhill.	The best I have ever seen.	It cannot be beat; only when the land is dry.
E. THOMPSON, Armin, by Howden.	Very valuable when the land is dry. In some seasons I could not plant my potatoes, or sow turnips, without its application.	
J. MECKLETHWAITE, Ardley House, by Barnsley.	A most valuable implement. It also possesses one great advantage, in not cutting or breaking the twitch.	

REPORTS—continued.

Query 3—Light Lands.	Query 4—Wireworm and Grub.	Query 5—Grass Lands, &c.
More beneficial upon light lands than upon strong, in consolidating the soil about the plants.		
It answers well for both these purposes.		
		It is very useful on grass-lands in effectually breaking the lumps of lime and earth; and by running a bush after, makes it quite fine.
It makes the land more firm than the presser; and in the spring, after frost, the land is not liable to scarp, as after the common roller.	It is invaluable for giving that solid texture, forcing the vermin down from the roots of the plants, which the common roller is not able to perform.	
Most excellent.		
	Very advantageous in stopping the ravages of the wireworm upon strong land after clover-stubble.	
Of essential benefit.	I think its greatest utility is in stopping the ravages of the wireworm.	
Answered in Query 2.	Very useful. I have this season a particular example of its use.	
Of great use upon light soils, after wheat is sown. In some seasons I might lose half a crop without it.		
I have used the clod-crusher in the spring, upon wheat sown on light soils, with great benefit.		

	Query 1—Crushing Clods.	Query 2—Strong Lands.
JOHN DRAEWELL, Thurcroft Hall, by Rotherham.	I purchased my clod-crusher of you in the spring of 1842, and have made several operations with it, the results of which I have now much pleasure in communicating to you. After a heavy crop of turnips on strong limestone land, which was eaten off by sheep during the wet weather, it was ploughed up for barley. The soil tore up in cakes and clods as hard as bricks. I know no implement which would have enabled me to reduce this land to a proper tilth, to sow barley, but your clod-crusher. Its cost of 30 guineas was abundantly repaid by the crop. I have found it equally serviceable in preparing my stronger lands for turnips last season; and have this year 17 acres of strong hazel land upon a strong clay sub-soil, which is now drained every 4½ laads, burying 60 full loads of stone per acre, besides tiles, &c. The whole was done in March and April; and we have now growing upon this land 13 acres of turnips, and 4 of rape, as promising as any in the neighbourhood. The soil has always been considered much too strong for turnips, and without the clod-crusher any attempt to prepare it this season would have been quite out of the question.	I have used your patent clod-crusher, for wheat, upon land consisting of limestone, gritstone, and strong land, sown partly in autumn and partly in the spring. I have in each instance left a portion unrolled; and those parts show the evil arising from the grub, wireworm, and blight, in different situations, to the amount of 6 to 18 bushels to the acre.
T. C. JOHNSON, Cherit Grange, by Wakesfield.	I am perfectly satisfied that it is a good implement, and has been of great benefit in breaking up my hard turnip-land.	
Right Hon. Lord HAWKE, Womersley Park, Pontefract.	I have tried your patent clod-crushing roller which I purchased of you last spring, and it fully answers my expectation.	
Sir J. V. B. JOHNSTON, Bt., Hackness, near Scarborough.	My agent informs me that he has found it most useful in the preparation of land for sowing turnips: without it, indeed, it would have been very difficult to obtain a sufficiently fine surface for the reception of the seed. One of the principal tenants also used it, with great success, for the same purpose.	
J. BEAUMONT, Brantingham.	I think it most invaluable.	Excellent for this purpose.
WILLIAM STICKNEY, Ridgmount, Holderness. 8th mo., 2, 1843.	A most excellent implement for breaking up clods upon our strong land fallow, and thereby liberating the seeds of weeds, which then come in contact with finer and moister mould, by which means they vegetate, and after-operations destroy them. Also, it frequently happens that a considerable quantity of the roots of couch-grass are enveloped in the large clods, which our harrows and the common roller will not break: the clod-crusher will scratch them out, and expose them to the sun and atmosphere, by which means they wither, and die.	Sometimes most excellent. I mention one circumstance in particular:—A neighbour of mine had sown a large field with oats, very dry and cloddy. The harrows had but little effect in covering the seed, but were borne up by the clods, which were only rolled from one place to another, the land being very dry on the surface. Both my neighbour and I thought there was little prospect of a crop. I lent him my clod-crusher, and he rolled it. The points of the roller pressed a large portion of the seed in contact with the little moisture left in the land. The soil from the crushed clods covered the seed, and it soon vegetated, and produced a good crop, much beyond our expectation.

REPORTS—continued.

Query 3—Light Lands.	Query 4—Wireworm Grub.	Query 5—Grass Lands, &c.
<p>I may here say that my neighbour, Mr. Hall, of Riveton Park, broke up some grass-land this spring, and sowed oats, using the clod-crusher. I did likewise, but did not use the clod-crusher. Mr. Hall is reaping 3 to 4 quarters per acre more than me, and I have no doubt that your patent clod-crusher has made all the difference.</p>		<p>I have used the roller after draining <i>grass-land</i>, preparatory to applying bone-dust, and again after having sown the dust; and found from the parts omitted that <i>the application has been attended with the greatest advantage.</i></p>
<p>One of the best purposes it can possibly be used for.</p>		

	Query 1—Crushing Clods.	Query 2—Strong Lands.
C. COATES, Beelsby, by Grimsby.	I have seen no implement equal to your clod-crusher, for this purpose.	It is particularly valuable for strong turnip land, when late eaten off in the season for barley.
Mr. R. REYNARD, Beelsby, by Grimsby.	Very useful. I would not part with it for three times its value.	It answers uncommonly well for this purpose.
FRANCIS LILES, Barnoldby-le-beck, by Grimsby.	I have, from long experience, found it to be a most valuable implement; and think no farmer's establishment is complete without it. I have in several instances broken up exceedingly strong fallows on my farm at Barnoldby, which is a clay soil; and have also been enabled to sow barley in the spring, with good effect, when otherwise I should have found it impossible to do so. I have also this season been enabled, by the aid of your crusher, to break up and work 50 acres of strong wold-land, on my farm at Wold Newton, for turnips, with the best effect—the plants growing and looking remarkably well thereon. Of the general utility of your clod-crusher I can speak most positively; and I feel fully assured that no one, after giving it a fair trial, will ever regret having made the purchase.	Upon wold and light lands I consider it very valuable for rolling wheat as soon as sown, when the season will admit, as by its peculiar action on the land it gives a firmness to the plant which prevents its being worked out by the winter frosts. I have also used it the last two seasons upon my barley in the spring, after the plant was up, and well grown, and where the clods were rough and sharp, immediately before sowing the small seeds, the result of which has been most satisfactory. The seeds have taken better than I ever had them before in the same fields; and so far from the blade of the barley being injured, which I had feared, I had full proof that the crop was benefited, which I can only account for by the peculiar action of the crusher giving firmness to the plant, and retaining the moisture without leaving the land in a sad or heavy state.
THOMAS KIRKBY, Cuxwold Villa, by Caistor.	Very valuable for crushing clods, and breaking up the strongest fallows in the driest seasons.	In my opinion it is an implement that no farmer should dispense with, being wanted, as the seasons vary, both upon light and strong soils.
WALKER DAVY, Thorsway Grange, by Market Rasen.	I have used your clod-crusher, and found it a most valuable implement. It will reduce my clods to powder, and break up the strongest fallows in the driest seasons.	It may be used at any time after sowing, with the greatest safety and much advantage; and upon lands sown late, which are cluddy in the spring, it has a better effect than any other implement I have ever seen.
WILLIAM WITLAM, Louth.	Your clod-crusher has been of great service to me this season. I consider it a first-rate implement. It reduces the land to a fine mould, and leaves it much opener than a stone roller.	The land requires to be dry, when its use at all times is of great benefit. In my opinion it is the best implement ever come out for all sorts of soil.
C. C. ROBSON, Cadesby Hall, near Louth.	I have found it essentially useful, and a great saving in labour, in producing a fine mould.	
Rev. F. PEEL, Willingham Rectory, by Gainsborough.	It reduces the rough fallows on very strong lands most effectually. I could not grow winter-tares as a preparation for wheat, or set my bean-stubbles in order in dry seasons, without it.	I find it often very useful in getting in my spring corn, when the ground is dry and rough. In short, I consider it a great boon indeed to the strong-land farmer.

REPORTS.

Query 3—Light Lands.	Query 4—Wireworm and Grub:	Query 5—Grass Lands, &c.
<p>In both cases I think it exceedingly useful. In the last spring I had a piece of wheat upon rather light, thin, rutted chalk-land, which was perceptibly losing plant every day from the effects of the winter's frosts. As soon as the weather permitted, which was in the last week in March, I had it rolled with your crusher, after which it began regularly to improve, and now is looking very well. The large iron roller would in such an instance as this do no good whatever, but rather harm, as by merely going over the surface it pulverizes the light top soil, without giving the necessary adhesiveness to the plant; and should dry windy weather ensue, the plant is bared, and left in a worse condition than before, whereas the action of your clod-crusher is similar to that of treading with sheep, going down to the root of the plant, and leaving it firm and secure.</p>	Had no experience.	Had no experience.
<p>I have found great benefit from using it also upon light lands soon as sown, and in the spring after frost.</p>		
<p>I consider it infinitely preferable to any roller, as it leaves the land without a smooth surface.</p>	<p>Upon a comparison of the state of my farm before the use of the patent clod-crusher, and subsequently, I am bound to state that the wireworm and grub have been much less prevalent.</p>	
Of great advantage.	<p>Many crops are saved from the wireworm by this implement.</p>	<p>Quite satisfactory. It does immense execution in breaking down.</p>
	<p>It produces a fine turnip-mould which retains moisture, and induces a quick and regular growth of the plants, and prevents the ravages of the fly.</p>	
Of great advantage for this purpose.	Very useful for this purpose.	

	Query 1—Crushing Clods.	Query 2—Strong Lands.
WILLIAM HUTTON, Gate Burton, by Gainsborough.		
C. BAYLER, Riseholme Grange, by Lincoln.	Superior to any other implement I have ever seen.	I have used it, with the best effect, upon corn-land in the spring.
E. CLARKE, Canwick, by Lincoln.	By far the most valuable implement I have yet seen for this purpose.	
S. HODGKINSON, Greetwell, by Lincoln.	I have derived great benefit from it. Indeed I should not have got my fallows in order without your clod-crusher. On my strong clay fallows it has very much forwarded my work.	I roll all my wheat with it after the frosts, and soon see a great change.
J. G. STEVENSON, Skellingthorpe, by Lincoln.	I consider the clod-crusher indispensable. This year my fallows never could have been got in order for turnips without it, or my neighbour's either, to whom I lent it, and who will have one before another season.	My wheat has generally lost root in the winter and spring. Last year I rolled it as soon as drilled, and also early in the spring, and never had it so good.
FREDERICK STRAW, Skellingthorpe, by Lincoln.	The most useful of all agricultural implements, when the land is rough and out of condition.	
J. B. SLATER, North Carlton, by Lincoln.	I consider your implement exceedingly beneficial for this purpose. I broke up a piece of grass-land full of ant-hills; a very rough field. After ploughing up the hills we used a heavy ox-harrow, and when dry employed your clod-crusher over the ground twice. The land was sufficiently pulverized to grow a good crop of turnips without any further ploughing.	
R. COLLETT, Swinthorpe, by Lincoln.	Invaluable.	Very useful.
R. S. GRABURN, Bramswell Cottage, by Sleaford.	I have had two of your clod-crushers in extensive use, and find it admirably calculated for this purpose. I should feel greatly at a loss without its aid; also a great saving of horse-labour is effected upon strong soils.	When the weather will permit the operation, immediately after sowing the wheat, it gives great firmness to the soil, which is beneficial to the growing plant discouraging to grubs, and gives a garden-like finish to the cultivation.
H. HANDLEY, Culverthorpe Hall, by Grantham.	I have used your clod-crusher upon my strong clay farm, and found it very effective in preparing fallows, especially on tare-ground ploughed in summer after the removal of the crop.	
W. B. WINGATE, Hareby, by Bolingbroke.	Your clod-crusher is a most useful and valuable implement, and an article no one should be without, occupying strong and tenacious soils.	

REPORTS—continued.

Query 3—Light Lands.	Query 4—Wireworm and Grub.	Query 5—Grass Lands, &c.
<p>I borrowed one of your clod-crushers of my neighbour, the Rev. F. Peel, of Willingham, to roll my new-sown wheat with, on my light soil, and am so far satisfied with the appearance of the wheat now that I desire you to send me one by the 25th of September.</p>		
<p>For these purposes it is infinitely superior to the common land-roller. It makes our land more solid, and at the same time prevents the dry March winds from blowing the corn bare.</p>	<p>Here again I prefer it, for the same reasons as in the answers to the preceding questions.</p>	
<p>I have derived most benefit from it in rolling some light fresh taken-up land, ravaged with the wireworm. The first year I thought nothing could save the wheat; but very soon after using your crusher it began to flourish at the root, and gather. I reaped a very abundant crop. I have rolled the same description of land twice over with it this year, where the wireworm had begun, and my wheat looks very luxuriant.</p>		
<p>I have always rolled my light lands with it in the spring, and believe it equally valuable upon light-land farms as upon strong. Wherever wheat is grown, and wherever turnips are intended to be grown, it is of great benefit.</p>	<p>I consider it very useful for this purpose, if used early enough. My wheat appears to have improved after using the clod-crusher.</p>	
	<p>Especially useful for all lands subject to the wireworm and grub.</p>	
<p>Upon our heath and cliff lands after ploughing, and previous to drilling in the autumn, and again in the spring, it is attended with a very beneficial effect, it gives a greater degree of solidity, and more firmly secures the root.</p>	<p>I find it, for stopping the ravages of the wireworm and grub, a very useful and effectual implement.</p>	
<p>In both cases I have used the implement extensively, with considerable advantage. I have derived great advantage from consolidating the soil after it has been lightened by the action of the frost.</p>	<p>P.S. In justice to yourself as the inventor, I am enabled to state that at no meeting of the Royal Agricultural Society has there been exhibited any essential improvement upon your original invention.</p>	

	Query 1—Crushing Clods.	Query 2—Strong Lands.
ROBERT DAWSON, Strubby, by Alford.	Your clod-crusher has been of great advantage to me in several instances, when the land had become cloddy and sufficient mould could not be raised to cover the seed. In one instance, especially, the crop of turnips would have almost entirely failed, if I had not used the clod-crusher. I have also used it with good effect after the corn was sown; and I can with pleasure bear testimony to the excellency of "Cromskill's clod-crusher."	
C. G. HOLLAND, Carrington House, by Boston.	Upon my two strong farms I have used two of your clod-crushers, and am thoroughly convinced of their superiority over every other implement as yet invented for strong clays. Your clod-crusher after passing twice over has prepared fallows when no common roller would have made any impression. It does not sodden the land like a common roller, consequently it leaves it in a much better state for the next ploughing.	
JOHN MOSSEP, Moulton Marsh, by Spalding.	The clod-crusher will do more execution in going over rough dry fallows than any other implement I have ever seen work; it will have the desired effect when all others fail. I was allowed to try your clod-crusher previous to becoming a purchaser; I no sooner got to work it than I found it did more execution once over than my heavy iron roll would have done in ten times; in fact I could not get the land fit to receive seed without it.	Upon lands sown late it is invaluable.
The Hon. and Rev. W. PEARS, Uffington House, by Stamford.	For the purposes 1, 2, 3, and 4, I have used "Cromskill's patent clod-crusher," and after three years' experience I can with confidence say, for all these purposes, it is the very best and most economical implement that a farmer can have upon his farm. Several of my neighbours are of the same opinion.	
G. H. BETTS, Ketton, by Stamford.	I had a convincing proof of the utility of the clod-crusher upon my strong land this spring. I decidedly could not have sown my barley without the use of it. I assure you I should be very sorry to be without it.	It breaks the crust on the top and makes solid the earth at the root; while it leaves the top surface in a nice state for the plant to tiller in; while the common roller merely breaks the top surface, and if wind succeeds, does injury rather than otherwise, by blowing it away.
STAFFORD O'BRIEN, Blatherwicke Park, by Wansford.	A most valuable implement; I have chiefly used it for crushing clods; it does its work far better than any implement I ever used or saw. I could not manage my farm without it.	It answers well to roll corn just sown.
CHARLES TUNGE, Branston, near Lincoln.	The best possible implement for the purpose; and the only one I have found to answer the purpose.	Very good for rolling wheat as soon as sown, if your land is dry enough for it to work. I consider it the best implement of the kind, and one that every farmer would like to possess, and trust that the inventor may get well paid for his invention.
WILLIAM DODS, Gosberton, near Boston.	I have had your clod-crusher so short a time, that I can scarcely give you my testimony of its actual experience, not having used it at seed-time: certainly as far as I have used it I consider it a most valuable implement; and shall not fail to recommend it to my neighbours.	

REPORTS—continued.

Query 3—Light Lands.	Query 4—Wireworm and Grub.	Query 5—Grass Lands, &c.
	<p>I crushed a field of oats (sown upon seeds fresh broken up) where the slug and wireworm were making great ravages, and I may confidently say I am indebted to your implement for as fine a crop as can possibly be. It is an excellent implement in preparing seed-lands, fresh broken up, for wheat.</p>	
	<p>By pressing and working the land down solid, it gives it a chance to strike afresh, like a plant fresh set, and thus recovers itself.</p>	
	<p>It arrests the progress of the wireworm very much, if taken in good time; and I have known it of particular benefit.</p>	

	Query 1—Crushing Clods.	Query 2—Strong Lands.
H. WATSON, Walkeringham, near Gainsborough.	I have had so little time to use the clod-crusher, that my experience, I think, will avail you but little. I have found it most invaluable for crushing clods.	
J. H. S. KIRKWOITH, Normanby, by Market Rasen.	For crushing clods and breaking up fallows in a dry season, I consider it the most effective implement ever invented; in fact, a piece of land belonging to my neighbour, Mr. E. Young, could never have been got ready for sowing turnips this year, if it had not been for your valuable implement; it was baked so hard and dry, that a heavy iron-roller had no effect upon it; he passed the clod-crusher over it once, and most effectually pulverized it for drilling, and a very fine crop of turnips is the result.	Last year was the first time of my using your clod-crusher on wheat directly after sowing. I used it on a 30-acre field, part of which I left undone, purposely, about 5 acres, which I had rolled with a common roller, and harrowed afterwards with a pair of light harrows. From the first appearance of the wheat, the part rolled with the clod-crusher was decidedly the best (and many people who rode past the field remarked it, and inquired of me the reason) up to the time of going into ear, when the difference was then not so good to see, but I fancy since cut there appears to be a greater bulk of straw where it was rolled with the clod-crusher.
THOMAS DIXON, Osgodby, by Market Rasen.	I consider the clod-crusher extremely useful on clay-lands, and when a farmer is anxious to obtain a turnip crop on strong land, he ought not to be without one; as, in some seasons, it is impossible to get strong land properly worked or fine enough for turnip-seed; and be the season ever so dry, the clod-crusher, by passing two or three times over the clods, will reduce them, I may say, to powder. I left my farm at Isley last May-day, and am at present out of the farming business. At my sale last May-day, the crusher was sold within 30s. of its cost, after I had used it four or five years, which fully proves the estimation it was held in.	

NOTTINGHAMSHIRE

The Duke of PORTLAND, Welbeck Abbey, Worksop.	Perfect.	
J. D. CLARK, Barnby Moor, East Retford.	I am happy to say I have one of your patent clod-crushers, and have found it the most valuable implement I ever saw in breaking up the clods on strong clay lands.	
MR. JOHN NOTON, Baillif to R. ARKRIGHT, Esq., of Sutton Hall, Derbysh.	We have found it answer upon strong fallows better than any other implement.	
S. S. SHOOT, Kingsey, by Tuxford.	I have tried the clod-crusher upon strong clay soil. For instance, I had a field of turnips which were eaten off when it was wet; it was ploughed up, and baked very dry; had it not been for your crusher, I should not have got it sown with barley.	I have used it for rolling wheat in the spring, and found it answer very well. I consider it a very useful implement.

REPORTS—continued.

Query 3—Light Lands.	Query 4—Wireworm and Grub.	Query 5—Grass-Lands, &c.
	I have found it very beneficial in regard to the grub.	
<p>I had another field of 27 acres (adjoining the one before-mentioned) which was sown with wheat; I intended to treat it in the same manner as soon as sown, but in consequence of the weather being wet, it was impossible to use either the common roll or the clod-crusher, I was therefore obliged to let it take its chance, although it is more subject to the wireworm than any field I have on my farm, and has been so since I have known it. The field of wheat was on clover-ley; it was a very bad crop of clover; in fact, the wireworm had destroyed it for acres together, all over the field, in patches. I had very bad faith of the wheat ever being a crop, although it looked pretty well during the winter; in the spring it was very evident the wireworm had begun its ravages; it was more perceptible every day that I looked at it; and I think in a short time half the field would have been destroyed; however the weather fortunately became dry, and I was enabled to use the clod crusher. I used it first across the lands, and afterwards lengthways of them, and most fortunately it stopped their ravages, and there was no appearance of wireworm afterwards. I am now cutting the wheat, and have a good bulk of straw, whatever the yield may be. It has amply repaid me for the cost of it in this very field the first year. In my humble opinion it is the best implement ever produced, and no farmer ought to be without one, either on light land or strong.</p>		

REPORTS.

I have experienced very good effects on our light land in Nottinghamshire. In rolling our wheat it answers far better than the common roller.		
	Also upon barley affected with the wireworm, where it had a good effect.	

	Query 1—Crushing Clods.	Query 2—Strong Lands.
J. E. DENISON, M.P., Ossington, by Tuxford.	Your clod-crusher is a very valuable implement in preparing fallow land in dry seasons. It reduces the size of the clods to such proportions that the first shower of rain makes them fall into mould; when, without your clod-crusher, it would have been impossible to get the land fit for any sort of spring or summer cultivation.	It is very valuable for autumn sown wheat in the spring, even on strong land. I rolled one part of a field with your clod-crusher, and left part unrolled. The superiority of the part rolled was very evident.
JOHN PARKINSON, Ley Fields, Newark.	It is superior to any other implement I have tried for crushing clods on strong lands.	It is of very great use in preparing the land before and after sowing corn, and especially with reference to the growth of clover and grass seeds sown therewith.
J. W. NEWSTEAD, Dunham on Trent, Newark.	I have found it of great benefit in breaking up my land for spring-corn and for turnip-land. I should not have got my strong land sufficiently fine for barley this spring without it: I really do not know what I should do without it.	A very excellent implement for rolling wheats in the spring of the year, especially on clover-leys and seeds, which lie rather hollow, and very frequently lose plant, if not pressed down after frost.
ROBERT FAULKER, Beckingham, Newark.	I have had little occasion to use it for this purpose.	I have used it with excellent effect upon land sown with wheat after turnips in the spring; it is now my invariable practice.
SAMUEL ABBOTT, Lowdham, near Nottingham.	I cannot speak more highly of your clod-crusher than it deserves. It is the most powerful and efficient pulverizer of land that I ever met with.	It is also invaluable for rolling corn in the spring, when there is a danger of its losing root.
W. W. MOODY, South Leverton, near Retford.	I have only had your crusher this season, and find it the best implement ever introduced in our part of the country for these purposes.	

DERBY, LEICESTER, WARWICK. GLOUCESTER

	Most valuable.	Good for rolling corn in the spring upon lands sown late in the year.
C. R. COLVILLE, M.P., Duffield Hall, Derby.		
JOHN WRIGHT, Romely, Chesterfield, Derbyshire.	I have had long experience with your patent clod-crusher, and have now reduced the strong land I occupy to good turnip culture; no season hitherto has prevented my having a good crop of turnips upon land where turnips were never attempted to be grown before. It is the most valuable implement we possess.	On strong land sown with wheat in the autumn, and on clover-leys before sowing, I have used the clod-crusher with very great advantage, also after sowing. I think it invaluable for rolling wheat in the spring of the year; it is also useful for land that has been fed on with sheep in a wet season before sowing with barley, and for rolling wheat in the spring; it ensures the growth of clover-seed.

REPORTS—continued.

Query 3—Light Lands.	Query 4—Wireworm and Grub.	Query 5—Grass-Lands, &c.
<p>I have no experience of its use in rolling light land; but I should imagine it would be greater even than on strong land.</p>	<p>It is very efficient in stopping the ravages of the wireworm. One of my tenants borrowed my clod-crusher to roll a field of barley. It was almost destroyed by the wireworm. It was so much injured that the prospect of a crop was estimated not to be worth more than 1<i>l.</i> per acre. loam. After once rolling with the wireworm stopped entirely. quarters per acre.</p>	<p>The land was a good but a strong the clod-crusher, the ravages of The crop of barley yielded 7</p>
<p>It is of great use upon light arable land, as it gives requisite compression without leaving a smooth surface. I have found it valuable for rolling turnips when the surface is crusted.</p>	<p>P.S. I do not know a farm of any description whatever whereon it is not applicable with benefit to the occupier. No farm of considerable extent ought to be without one.</p>	
	<p>An invaluable implement; it stops the ravages of the wireworm most effectually.</p>	
<p>I am much pleased with its operation: it presses the soil to the roots of the plant, and leaves the land firm. <i>It acts in the same manner as a gardener presses the soil to the roots of a plant with a setting-stick.</i> The common roller acts as if, after putting his plant into the hole, he merely contented himself with putting his foot upon it.</p>	<p>This question I can answer most decidedly. I am much troubled with the wireworm, and generally I have found once rolling with your clod-crusher sufficient, when the land is in a proper state. <i>I have never found the wireworm able to work after twice rolling.</i></p>	

AND HERTFORDSHIRE REPORTS.

	Query 1—Crushing Clods.	Query 2—Strong Lands.
S. JOHNSON, Somersall, Chesterfield.	I have used your clod-crusher for several years, and have found it of the greatest possible benefit. In regard to the questions contained in your Circular, Nos. 1, 2, 3, and 5, in all which I have tried your clod-crusher, I found it most invaluable.	
HENRY WOOD, Cropston, near Mountsorrel, Leicestershire.	I have great pleasure in conveying to you my experience of the clod-crusher, which I was induced to order of you last year, after the loan of my neighbour's, Henry Paget, Esq., of Bristol. I deem the implement invaluable on all lands subject to stick in ploughing, and which are incapable of pulverizing in parching dry seasons. I first used it, and succeeded in reducing a seven-acre close to a barley tilth in one day.	I have this year rolled all my wheats with it in the spring, and with decided advantage. N.B. In the present very depressed state of agriculture, landlords could not confer a greater benefit on their tenantry than by keeping implements, like the one in question, for the common use of the occupiers of their land.
R. FULSHAW, Knighton, Leicestershire.	I have great pleasure in answering your questions respecting your patent clod-crusher, having tried it in all several times, and find it answer remarkably well.	
J. B. BUSHEL, Coleshill, Warwickshire.	No implement ever came under my eye equal to it for this purpose.	
J. B. MASSEY, Buntingford, Herts.	It answers remarkably well.	It exceeds my most sanguine expectations.
WILLIAM THOMAS, Soilwell, Gloucestershire.	Very valuable.	More suitable than any other implement.

NORFOLK.

Thorpe Abbott's Hall, near Scole,
September 12th, 1843.

SIR,—As touching your question relative to the “advantages resulting from the use of the patent clod-crusher upon my farm in one year more than if I had not had a crusher,” I beg distinctly to state that I have been benefited to an extraordinary extent, both as regards the preservation of wheat from the ravages of the *wireworm*, and in the production of *root-crops*. I believe I was the first to introduce it into the county of Norfolk, and at first was much ridiculed when I wished to exhibit it at a neighbouring agricultural meeting. But it was not long before I was enabled to produce one of the finest beet-crops ever grown, and that too whilst many of the heavy land-fallows in the neighbourhood exhibited an almost total failure. For on the following spring the weather proving remarkably dry, and the late-broken fallow lands being extremely rough, I went to work with the crusher, rolling it twice over 11 acres of 30-inch ridge-work, upon which the mass of dry clods had previously been thrown by a double-breasted plough, and with the kind aid of a light rain which followed, the

Query 3—Light Lands.	Query 4—Wireworm and Grub.	Query 5—Grass Lands, &c.
One of my neighbours used the crusher upon several fields of light lands this spring, for the purpose of fastening his crops after frost, and for which purpose it has answered fully.	I believe I saved a close of wheat from the ravages of the wireworm by the timely use of this implement. P.S. My clod-crusher has been in such request that I have little doubt but most of our parishes will be induced to have one in common. This I recommend, as one crusher is capable of doing an amazing amount of work.	
Invaluable.	An effectual remedy.	
It answers remarkably well, and is a most valuable implement for this purpose: no large farmer ought to be without one.		
The only appropriate implement.		Decidedly very useful for this purpose.

finest tilth imaginable was produced, so that the seed went in and the plants came up in the best order possible, whilst most of my neighbours were still waiting for the rains, without which they could not move, and waited so long that their plants where they showed themselves were weak, irregular, and, as a whole, a complete failure.

It may, perhaps, be remarked that heavy lands are much more easily prepared for a root-crop by deep ploughing in the autumn, so that a winter's frost precludes the necessity of a clod-crusher. This I am quite ready to admit; still, from repeated observations, I feel assured that spring-broken fallow-land, if worked when perfectly dry, is much more certain to produce a full and healthy root-plant than broken land which has undergone the washing rains of a winter. Be this as it may, autumn cultivation cannot always be attended to; or by some it may be deemed expedient to produce something for spring-feed previous to a root-crop, in which circumstance the crusher, in nine cases out of ten, will prove itself invaluable.

If a writer who addressed the editor of the 'Mark Lane Express,' August 28, "On the Rotation of Crops on heavy Lands," had been acquainted with the use of the crusher, he would not

have doubted the practicability of Mr. Stace's scheme of growing tares, &c., after a fed crop of trefoil and rye-grass; nor have thought it indispensably necessary to sow early on a pulverized soil, and not on a fresh-broken-up ley, from which sheep had just been removed.

I am quite aware that by the "old," and what may now be truly called *the barbarous system of forcing heavy lands* by harrowing and rolling fresh after the plough, a mass of livery clod is produced, and a state of land which, as the writer says, "is fit for anything rather than the reception of seed;" but by what I shall call *the new system* of first ploughing the land and letting it remain untouched either with roll or harrow till thoroughly dry, and then pulverizing it with the clod-crusher, it would upon the arrival of

KENT, MIDDLESEX, SURREY.

	Query 1—Crushing Clods.	Query 2—Strong Lands.
Col. T. AUSTEN, Kippington, Seven Oaks, Kent.	I used your clod-crusher last year in preparing my land for mangold wurzel and Swede turnips, and but for your clod-crusher I should and must have lost my season for sowing; as it was, I never had a better crop, which I attribute in a great measure to the efficient manner in which the ground was pulverized by your roller for the reception of the seed. I may safely and conscientiously assert, that among all the improvements in our agricultural machinery, I know none that surpasses your clod-crusher roller.	It is equally successful in rolling corn after it has been sown, more especially in some of our dry springs, where I could, after the corn was grown up, see how far to a nicety the roller had gone.
THOS. FLIGHT, Laycock's Dairy, Islington, Middlesex.	I am happy to say that I have used your clod-crusher in the Isle of Sheppey with great satisfaction, and have recommended it to my brother-farmers on the island, who, I have no doubt, will patronize it also, as they are equally pleased with it.	
J. M. BROADWOOD, Lyne, near Dorking, Surrey.	My land is a stiff clay loam, which when ploughed wet breaks up in clods, that when dry become so hard as to defy the attempts of the harrow and common iron roller to reduce them. Your clod-crusher accomplishes this fully. I have this morning seen it reduce to a friable state an oat-ash field broken up since harvest, which, but for the operation of your clod-crusher, would not have furnished grit enough to have covered the seed. For all fallows I think your clod-crusher is invaluable.	
G. MATTLAND, East Grinstead, Hartfield, Sussex.	I am quite satisfied with your clod-crusher, and it is much approved of by all my friends here. It pulverizes much more effectually than any other implement, rendering the surface in a proper state for drilling in the seed.	The use of the clod-crusher is always beneficial when the land is dry. In my opinion it is a very valuable implement upon our stiff soils.
WILLIAM WALTON, Merdon Farm, Hursley, Winchester, Hants.	In the spring of 1842, I had 24 acres of swedes all eaten off by sheep in wet weather upon strong land. It ploughed up in lumps as big as horses' heads; without the clod-crusher I could not have got the land fine enough for barley. I grew 7 quarters of fine malting barley per acre. Several of my neighbours, who were in the same situation, had not a crusher, and grew 2 to 3 quarters of their barley per acre.	Strong land, which is too rough or cloddy to be sown with wheat, should be rolled with your clod-crusher previous to the last ploughing. It is invaluable in the spring, and saves a great deal of labour in rolling and harrowing, to get the land sufficiently fine for barley-seeds and turnips.
G. JENNINGS, Dover, Kent.	It answers well for strong and light soils. Very valuable for crushing clods.	

the first light shower be made entirely fit for the germinating of the finest of all fine seeds. In short, with this implement I now feel an independence in farming operations which neither rolls nor harrows can give me, and if even the small occupiers could but be persuaded to make the experiment, great as the sound of the expense appears to be, I am confident they would never grudge the original outlay for the implement, nor the cost of working it.

I have myself used it for upwards of two years, and I am quite pleased that your letter has given me an opportunity of testifying my sense of its value.

Yours respectfully,

JOSEPH PAUL.

To Mr. Crosskill, Iron Works, Beverley.

SUSSEX, AND HAMPSHIRE REPORTS.

Query 3—Light Lands.	Query 4—Wireworm, Grub, &c.	Query 5—Grass-Lands.
The answer to the former question speaks with equal force to this; for if the roller did good on the former case, it stands to reason that it must, if possible, do more good on light land loosened by the frost.		P.S. I have had no experience upon grass-land, but should infer, if we are right in our theory, that the treading of sheep is conducive to the removal of moss, the crushing-roller must necessarily be more so.
This question I consider to be most important. Light thin land must be compressed and got as close as possible together; to accomplish this, we tread the land with sheep after sowing wheat, which I have no doubt does the sheep a deal of harm in many respects. I consider the clod-crusher much better and safer for wheat. If rain comes after sheep treading, it leaves scale upon the land; the clod-crusher makes the land firm and close under, and a little rough at the top.	Where I have used the clod-crusher, my corn has not been ravaged by the wireworm or grub. I have no doubt it would be useful on mossy grass-lands. P.S. I have often said at the markets, and now repeat it, that if there was not another clod-crusher to be got, I would not take a thousand pounds for mine. I have 500 acres of light and 300 acres of strong land under the plough. It is invaluable.	

	Query 1—Crushing Clods.	Query 2—Strong Lands.
JOHN POWELL, Bovertan Castle, Cowbridge, Glamorgan- shire, Wales.	It reduces clods perfectly in the driest seasons, although it sometimes has required a second application, more particularly for barley after turnips. I have found it a most valuable implement upon strong lands.	I was so much satisfied with its results, both last year and the year before, when I tried it upon some of my wheats in the spring, that I have this year applied it to the whole of my wheats with the same beneficial results.
JOHN OMEROD, Bryn-y-Hynon, Ruthin, Wales.	I can merely state that I have tried your clod-crusher for breaking up rough, cloddy land, and also for preparing land for turnips, and have found it to answer very well, provided the soil be in a dry state.	
G. JACSON, Barton Lodge, near Preston, Lancashire.	I have only the experience of this season, during which I have found it a valuable implement.	Exceedingly useful.
REV. C. GLYNN, Hawarden Rectory, Chester.	I am very glad to have this opportunity of bearing witness of the efficiency of your patent clod-crusher. I have used it entirely upon the strongest fallow, and am confident that without it, in a dry season, one particular field of blue clay in my occupation could not have been worked at all. I have lent it to many of my neighbours, who all express their unqualified approbation of its usefulness.	
W. JONSON, Chillingham Newto wn, Wooler, Northumberland.	I have found it most valuable in crushing clods, on soils which are tenacious, in preparing them for turnips in a dry season. Also for similar soils, after turnips, in a dry season. In the month of April, in preparing for barley, I have found it a most useful and efficient implement. It was my steward's opinion, in consequence of very dry spring seasons, some of my clay-soils, intended for green crops, would have remained fallow had I been without the implement.	I ploughed, harrowed, and clod-crushed a field of this description of 24 acres, after turnips, and had a crop of barley of 60 bushels per acre, by which I reckoned the produce was nearly doubled.
H. CLIFFE, Bellevue, Enniscorthy, Ireland.		I have used it in rolling wheat with good effect, and in preparing light land for turnip-crops.

XVIII.—On the Improvement of Marsh Land.

By JOHN MURTON.

HAVING tried an experiment on some second-rate marsh land in this part of the county, for the last ten years, and now being able to prove, to the satisfaction of every one, its great advantage to labourer, tenant, and landlord, and intending to continue my plan, I much regret my want of ability to do justice to it, with the view of persuading others to give it a trial.

I have been in the occupation of upwards of 300 acres of marsh land, more or less subject to a coarse grass we call sword-grass, with the ditch-bank 2½ feet above the level of the land, and 3 feet above the water. To improve this grass, or get stock to eat it, I have tried salt, lime, and chalk; but as none of these answered to my satisfaction, in the year 1831 I commenced, on a marsh of 4 acres, by first cutting the ant-hills, and

Query 3—Light Lands.	Query 4—Wireworm, Grub, &c.	Query 5—Grass Lands, &c.
Wheat on strong and light lands, and especially on stony and gravelly lands, are greatly improved by the use of the clod-crusher in the spring, particularly after turnips and clover-ley, it is much superior to the peg-roller after sowing.	I have no hesitation in saying I have found it a specific to the wireworm. P.S. In my opinion no farmer should be without one.	
	Very valuable.	

then setting a number of men to barrow the ditch-bank into the middle of the marsh, finding I had sufficient mould to cover it all over about $1\frac{1}{2}$ inches thick. I then sowed it with Tartarian oats, about 5 bushels per acre, in the month of February, well harrowing the ground with an ox-harrow, having the large lumps chopped; then, as early as possible after the oats were up, rolling them twice or three times, and letting the oats and grass grow up together till harvest. They are ready to cut at least a week before the upland corn. I have them reaped sufficiently low to collect the corn; then set the scythe to cut, between the shocks, the grass and stubble, which is nearly knee-high. The latter I cart into a stack as soon as I can get it dry, adding some salt to every load. The oats I frequently bring home to a meadow to harvest, as it not only clears the marsh for stock, but finds advantageous work for my horses. In stacking the oats, I have a maun-basket drawn up the middle: they being nearly all corn, with so little straw, are apt to heat. After I had finished a second marsh of 8 acres in 1832, I requested my worthy landlord's attention to this improvement of his estate, who immediately

agreed to pay half the manual labour during my lease, if I barrowed at least 240 rods per annum. This formed part of my new lease then; and I am now under an agreement to finish those that have not been done. The result is as follows:—

In 1831 I covered the before-stated 4 acres, cleared 322 quarters of oats, paid 1s. per quarter for thrashing, and cut at least a load of brushings. 1832, 8 acres. 1833, 14 acres. 1834, 7 acres: this marsh I chalked about 3 years before. 1835, 19 acres: in this marsh I limed 120 rods of bank during the summer with unslacked lime, and in the winter it might have been moved with a ba'n scuppet; nothing extra good in this crop, but I feel assured the marsh is improved more in proportion than those without lime. In 1836, 22 acres. 1837, 16 acres. 1838, 14 acres. 1839, 15 acres: earthed, but not sown with oats; I do not think the marsh covered itself so soon with grass, there being no oats to keep the sun off, or seeds to shatter. In 1840, 16 acres. 1841, 17 acres, with more than 10 quarters of oats per acre. In 1842, 22 acres; and I have now a crop growing with at least 9 quarters per acre.

I usually commence this work in the month of December, and employ from 10 to 20 men extra during the barrow-work. I pay from 2s. 6d. to 3s. 6d. per rod-run, measuring close to the edge of the water: by that means the labourer is justly paid for all crooked ditches. The price varies according to thickness of bank, and distance to wheel it; and my rule is for each man to shoot 9 barrows to the half rod, which is the best thickness for a crop: the oats then get well hold of the turf. After all that can be barrowed, the corners are carted to the middle of the marsh, or parts too far for the men to wheel. As soon as the bank is finished, I use a foot plough round where the bank has been taken, so as to allow the frost to pulverise it for a season.

This not only produces work for the first winter, but additional threshing for the following one; increase of food for lean beasts, and a greater quantity of manure for the uplands; keeps the cash at home, able men out of the Union, and lightens the rates.

I use about 60 acres of marsh land belonging to the adjoining estate. None of these banks have yet been removed; and this year, since lambing, I have lost more stock on these 60 acres than on all those that have the banks removed.

My neighbour, Mr. Oakley, said, after a snow-storm, he considered the removal of my banks had saved him in one night near 10l. Mr. Ellis, of Barming, near Maidstone, who had lost his way, I found in my marshes looking at a growing crop: he stated his surprise at the vast improvement, and said he was never more agreeably lost, as he considered he had obtained information.

Those marshes that have been done a few years I consider very much improved. They keep more stock, and yield grass of a much better quality; much less sword-grass, no drinkings required for the stock, and if a lamb falls in it can walk out on either side. As to appearance, it is beyond me to describe the improvement.

I would state the cost per acre more correctly if I could; but this must be governed by the number of acres in each field, and more particularly by the form of it, as a field that is long and narrow (say 30

rods across) will not require carts for the corners, but if square, carts are required for the great distance.

Should this meet the approbation of some, and be the means of employing a few hundreds whom the frost and the want of other employment would otherwise drive to a workhouse, I shall consider I have done some good to the labourer, ensured myself the approbation of the landlord, and thanks from the tenant.

Cooling Castle, near Rochester, Kent,
7th August, 1843.

XIX.—*Reports on Wheats selected for Trial at the Bristol Meeting.*

1. *Report from PH. PUSEY.*

THESE wheats, of which No. 1 was white and Nos. 2 and 3 red, were drilled on a deep strong loam, as had been desired, on the 15th of October, by the side of some other varieties, among which were the old Red Lammas, and the Hopetoun, a kind of Hunter's white, after vetches fed off. Mr. Brooks, who occupies the farm, gives the following account of their progress:—

No. 1 was remarked by every one as being higher and forwarder than any other wheat during the winter.

In May all the wheats became flaggy in consequence of the incessant rain.

No. 2 came out first in ear: though its straw was thicker than that of any other wheat, it was laid nearly a fortnight earlier than the rest, almost as soon as it came into ear.

The other red wheat, No. 3, was the latest in ear; its straw was weaker than any Mr. Brooks had ever seen, resembling grass; it fell to the ground before the ear appeared.

At harvest the ears of the two red wheats were found to be so much mildewed, in consequence of their having been completely laid, that they contained little else than tail wheat, and the produce consequently was not measured.

The produce of the white wheat No. 1, compared with the Hopetoun wheat which grew near it, was as follows:—

	Bushels.	Straw. Ton. Cwt.
1 acre Hopetoun wheat . . .	29	1 11
1 do. Wheat No. 1	26½	1 9

The produce of this land in a fair season must be nearly 40 bushels per acre. Mr. Brooks thinks that the wetness of May and June have prevented the selected wheats from having a fair trial; but he states that he should be unwilling to grow them upon his land.

PH. PUSEY.

2. Report from J. V. SHELLEY.

HAVING been appointed by the Council of the Royal Agricultural Society of England to test the seed-wheats, selected for trial at the Bristol Meeting of the Society, the following is my report of the result :—

Wheats given me for trial	<div style="display: inline-block; vertical-align: middle;"> { No. 1. Old Lammas (white). 2. Creeping Red (red). 3. Glory of the West (red). </div>
Wheats previously grown by me, or my neighbours, put in competition with the above	<div style="display: inline-block; vertical-align: middle;"> { 4. Danzig (white). 5. Salmon Brown (red). 6. Golden Drop (red). 7. Alfriston White. </div>

The field in which the wheats were sown slopes to the south, the soil a sandy loam, and the average depth from 5 to 6 inches; the subsoil a gravelly sand. The mode of cultivation on the four-course shift, viz., turnips fed off with sheep, each other row having been pulled and carried in for beasts, barley, seeds, mown twice for hay, followed by a dressing of lime at the rate of 160 bushels per acre. After once ploughing, not more than 5 inches deep, a heavy roller with eight oxen passed over the field, which was then harrowed with heavy harrows; the seed drilled in at the rate of $2\frac{1}{2}$ bushels to the acre, a sufficient space being left between the sorts to keep each separate. The sowing commenced on the 2nd of November, and was completed the following day, when light harrows being passed across the drills, and the water-furrows drawn out, the work was finished. The wheats came out of the ground about the same time, and no difference in them became visible until about the 10th of March, when the reds appeared to make a start about a fortnight previous to the whites. During the growth of the wheats, I observe by my memoranda, that Nos. 1, 4, 5, 6 had the best appearance throughout, and were not affected by blight; that No. 3 was the most blighted, the straw weak, like coarse grass, so that, although it was in the centre of the field, the whole was laid flat, the adjoining sorts being scarcely affected by the wind: the sample of No. 3 was lean and bad. The cutting and harvesting were completed by the 1st of September, in excellent condition, and after thrashing and weighing, the following tables show the produce of each per acre and the weight of straw.

No.	Quarters.	Bushels.	Gallons.	Quarts.	Pints.	Weight of Wheat.	Weight of Straw.
1. Head Tail	4 0	3 1	0 7	3 1	1½ 1	lb. oz. 61 9	lbs. 4455
2. Head Tail	3 0	4 1	6 5	3 0	1 1	61 5	4195
3. Head Tail	3 0	5 2	0 7	3 3	1½ 0	61 13	3980
4. Head Tail	4 0	1 0	3 7	1 2	0 0	61 5	3600
5. Head Tail	4 0	4 1	2 4	0 2	0 0	60 5	3320
6. Head Tail	4 0	4 1	3 5	3 0	1 1	61 5	4195
7. Head Tail	3 0	6 2	0 0	0 1	0 0	60½ 0	3525

By the above it will be observed that, according to the quantity of corn produced, the wheats will stand thus: Nos. 6, 5, 1, 4, 7, 3, 2: and in point of weight of wheat as follows: Nos. 3, 1, Nos. 2, 4, 6 equal, 5 and 7 lightest: in weight of straw thus: No. 1 greatest quantity, Nos. 2 and 6 equal, Nos. 3, 4, 7, 5.

Having thus given an exact account of the produce of each sort of wheat per acre, I have only, in concluding my report, to remark, that the sample of No. 1, white wheat, was particularly good, and that, taking into consideration the higher price it would bear in the market over the two reds, which stand only just above it in amount of produce, I have no hesitation in recommending the cultivation of the variety to farmers, having sown the whole of it again this year, and in believing it worthy to receive the prize from the Royal Agricultural Society of England.

Maresfield Park, Nov. 16th, 1843.

3. Report from the Rev. DR. WEBB.

DEAR SIR,—I herewith send you a sample of each of the species of wheat which you forwarded to me. I understood from you that there were only two species, one white, and one red; but upon examination I found one coomb of white and two of red. The coomb of white I sowed at Litlington, near Royston, and a coomb of red; the other

coomb of red I sent to this place, Great Gransden. The white and the red which were sowed at Litlington were sowed upon a clover layer, upon land of a chalky subsoil, and which had been strictly under the four-course system, turnips, barley, trefoil, or clover, and then wheat. The produce of $1\frac{1}{2}$ acre of the white was 40 bushels, and of the red 33 bushels. The white was a very good crop, but the red very inferior, and never had the fine appearance of the white, though sowed in the same field and adjoining each other. I also sowed some of the wheat which gained the prize at Oxford, of which I also send you a sample, and some red wheat which is called in this neighbourhood Clover's wheat; the produce of the Oxford white was 35 bushels, and of Clover's 45 bushels. All were sowed on an equal quantity of land, $1\frac{1}{2}$ acre, and the same quantity of seed. That of Clover's was sowed about a week after the others, which were sowed on the same day, the 24th of October. The wheat sowed at Gransden was sowed about the 1st of November, and was supposed to have been the same as the red wheat which was sowed at Litlington, but it proved to be a rough chaffed wheat, a very inferior sort of wheat, and was a bad crop though sowed upon a good piece of land which had been folded with sheep, and had had a clean summer fallow, and which was sowed contiguous to some sowed with Clover's wheat, which was a very heavy crop. I consider, and so do my bailiffs, that the white wheat is a very good productive sort of wheat, and we have sowed the whole of this year's produce again; the red wheat to be very inferior, small in produce, the ears with the corn very distant, and such as we have condemned to the miller to be ground. The produce of $1\frac{1}{2}$ acre of the red wheat at Gransden was not more than 25 bushels.

I am, dear Sir,

Yours very faithfully,

WILLIAM WEBB.

Great Gransden, near Caxton, Nov. 28th, 1843.

To James Dean, Esq.

Minute of Council : December 7, 1843.

"The judges of seed-wheat, selected for trial at the Bristol Meeting, having made their respective reports of the results obtained in cultivating the selected wheats along with well-known varieties of the neighbourhood in which each trial was made, the Council resolved, That although the white wheat promised favourably under certain circumstances, they had not at that time sufficient proof before them that it possessed the requisite amount of merit for the Society's prize; while the two red wheats appeared to be very inferior in every respect. As the comparison had been made during an unfavourable season, the Council decided that the white wheat should have the advantage of a further trial."

XX.—*On the Use of Growing Mustard for Feed, or to Plough in as a Preparation for a Wheat Crop.* By GEORGE JESTY.

SIR,—As a member of the Society, feeling anxious to communicate anything where there is a chance of improvement, I beg to hand you the following statement on the use of growing mustard for feed, or to plough in as a preparation for a wheat-crop. It is very palatable to all kinds of cattle, and I believe very wholesome: I think it far preferable to buck-wheat, or any other vegetable with such rapid growth. I sowed 5 acres on the 11th of July last, on rather inferior land, of a light gravelly soil with chalk subsoil, where early turnips for wheat had failed. It should be drilled 5 inches apart, with 12 pounds of seed per acre. On the 25th of August I had measured portions cut, in different parts of the field, and weighed, which, on a fair calculation, yielded 6 tons per acre—it was in full bloom—and the next day I ploughed it in; which I consider, being full of vegetable matter, must be an excellent dressing for a wheat-crop. I would invite any friend to make trial of mustard on better land than mine; the expense being so trifling compared with buck-wheat, which is 5s. per bushel, and requiring $2\frac{1}{2}$ bushels per acre, would be 12s. 6d.; whereas 12 lbs. of mustard-seed, at 2d. per lb., the price it is now selling at, would be 2s. per acre.

Any further information on this subject (if required) I shall be most ready to answer;

And remain, Sir,

Your obedient humble servant,

GEORGE JESTY.

*Druce Farm, Puddletown, near
Dorchester, Sept. 4, 1843.*

XXI.—*Successful Industry of a Labourer.* By J. BARTON.

In passing through Norfolk lately, I met with such a remarkable and pleasing instance of successful industry that I think the particulars may interest the members of the Royal Agricultural Society. Edmond Chaney, of Carlton Rode, 11 miles south-east of Norwich, aged forty-nine years, was brought home to his parish about twenty years ago, with a family of six children. The overseers granted him an allowance of 2s. 6d. per week, and supplied him with a wheelbarrow, desiring him to try to find employment in wheeling out marl from the pit to the land. He obtained work of this sort from a farmer in a neighbouring parish, who, finding him a sensible and industrious man, kindly lent him money to buy a donkey, and afterwards a pony, which he repaid from the produce of his labour. Some time afterwards, by the advice and assistance of the same kind friend, he engaged to rent 4 acres of land belonging to the parish in which he was settled. This undertaking proving successful, he hired 24 acres more, nine years ago last Michaelmas. Two years later, he engaged 23 acres more—14 of arable, and 9 of fen land—

with a dwelling-house and buildings; the following year 22 acres more; and he has recently added another 24 acres to his occupation: making in all 93 acres, the 4 acres belonging to the parish having been taken from him when he hired the other land.

In order to stock these different parcels of land, he was of course under the necessity of borrowing money; but by industry and good management he has been enabled to pay it off, and is now free of the world. To make his history still more remarkable, he has brought up a family of *fourteen* children, and buried two others.

The circumstances of the case, as I heard them related, appeared to me so extraordinary that I was induced to go over to Carlton to see the land, and to inquire into the system pursued with such admirable results. I found that Chaney has two sons grown up and married, who work for him as day-labourers; and three sons unmarried, who also work for him. In addition, he sometimes employs two or three other hands. He has five working horses, besides a brood mare and foal; nine breeding sows, and a boar; five milch cows, and nine young cattle of different ages. I did not see any sheep. I could not find that he adopts any regular system of cropping, but the appearance of his crops bore testimony to the high condition of the land, though originally, I was informed, of inferior quality. The great secret of his good management and extraordinary success seems to be in a very liberal application of manure and of labour to improving the soil. He told me that he never sells any barley, peas, or beans, but devotes his whole growth of these to the feeding of stock, chiefly hogs, of which he fattens a great number. The particulars of this case are so extraordinary that I should scarcely have given credit to them had I not verified them on the spot. They appear to me to furnish a proof as remarkable as it is delightful of the benefit of *high farming*.

Rent of the 24 acres originally taken . . .	20s. per acre.
Ditto, afterwards raised to . . .	22s. and 24s. „
Rent of land subsequently taken . . .	40s. „

East Leigh, Emsworth, June 10, 1843.

END OF VOL. IV.

